



April 25, 2017

FOUNDATION INVESTIGATION REPORT

**STRAIGHT LAKE NBL BRIDGE STRUCTURE, SITE NO. 44-461/1
HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529
NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 5347-08-00; WP 5145-08-01**

Submitted to:

URS Canada Inc.
30 Leek Crescent, 4th Floor
Richmond Hill, Ontario
L4B 4N4



GEOCRE No. 41H-165

Report Number: 09-1111-6014-5522

Distribution:

- 1 PDF Copy Ministry of Transportation, Ontario, North Bay, Ontario (Northeastern Region)
- 1 PDF Copy Ministry of Transportation, Ontario, Downsview, Ontario (Foundation Section)
- 1 Copy URS Canada Inc., Richmond Hill, Ontario
- 1 PDF Copy Golder Associates Ltd., Mississauga, Ontario

REPORT





Table of Contents

PART A – FOUNDATION INVESTIGATION REPORT

1.0 INTRODUCTION.....	1
2.0 SITE DESCRIPTION.....	2
3.0 INVESTIGATION PROCEDURES.....	2
3.1 Foundation Investigation.....	2
4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS.....	5
4.1 Regional Geology.....	5
4.2 Subsurface Conditions.....	6
4.3 South Abutment/Approach.....	7
4.3.1 Topsoil.....	7
4.3.2 Silt and Sand to Sand.....	7
4.3.3 Organic Silt to Organic Silt and Sand.....	8
4.3.4 Silty Sand to Sand and Gravel.....	8
4.3.5 Bedrock/Refusal.....	8
4.3.6 Groundwater Conditions.....	9
4.4 Pier 1 Area.....	10
4.4.1 Ice/Water.....	10
4.4.2 Organic Silt.....	10
4.4.3 Upper Silt.....	10
4.4.4 Clayey Silt.....	10
4.4.5 Lower Silt.....	11
4.4.6 Bedrock/Refusal.....	11
4.5 Pier 2 Area.....	12
4.5.1 Ice/Water.....	12
4.5.2 Organic Silt to Clayey Organic Silt.....	12
4.5.3 Clayey Silt to Clay with Silt and Sand to Silty Sand Interlayers.....	12
4.5.4 Silt.....	13
4.5.5 Silty Sand to Sand.....	13
4.5.6 Cobbles and Boulders.....	14



FOUNDATION REPORT – STRAIGHT LAKE NBL BRIDGE
HIGHWAY 69, GWP 5347-08-00, WP 5145-08-01

4.5.7	Sandy Gravel	14
4.5.8	Bedrock	14
4.6	Pier 3 Area	14
4.6.1	Ice / Water	15
4.6.2	Peat	15
4.6.3	Organic Silt	15
4.6.4	Clayey Silt to Clay	15
4.6.5	Silt	16
4.6.6	Gravelly Silt and Sand	16
4.6.7	Cobbles and Boulders	16
4.6.8	Bedrock	16
4.7	Pier 4 Area	17
4.7.1	Topsoil	17
4.7.2	Silt	17
4.7.3	Sand	17
4.7.4	Clayey Silt to Silty Clay	17
4.7.5	Silt	18
4.7.6	Boulder	18
4.7.7	Bedrock	18
4.7.8	Groundwater Conditions	19
4.8	North Abutment	19
4.8.1	Topsoil	19
4.8.2	Silt to Sand with Clay Interlayer	19
4.8.3	Refusal	20
4.8.4	Groundwater Conditions	20
4.9	North Approach	20
4.9.1	Peat/Topsoil	20
4.9.2	Organic Silt	20
4.9.3	Clayey Silt to Silty Clay (Pockets/Interlayers)	20
4.9.4	Silt to Sand (Upper Deposit)	21
4.9.5	Clayey Silt to Clay	21
4.9.6	Silt to Sand (Lower Deposit)	22



FOUNDATION REPORT – STRAIGHT LAKE NBL BRIDGE HIGHWAY 69, GWP 5347-08-00, WP 5145-08-01

4.9.7	Bedrock / Refusal.....	23
4.9.8	Groundwater Conditions	23
5.0	CLOSURE	24

DRAWINGS

Drawing 1	Index Plan
Drawing 2	Borehole Locations and Soil Strata
Drawing 3	Soil Strata
Drawing 4	Soil Strata
Drawing 5	Soil Strata

APPENDICES

Appendix A Record of Boreholes and Drillholes

Lists of Symbols and Abbreviations

Lithological and Geotechnical Rock Description Terminology

Record of Boreholes	B502-01 to B502-18, S502-08, S502-12, S502-18 to S502-20, S502-20A, S502-20B and 502-21 to S502-24
Record of Drillholes	B502-01, B502-02, B502-05 to B502-07, B502-09 to B502-13, B502-15 and B502-18
Record of DCPT	S502-DC02, S502-DC08 and S502-DC09
Record of Borehole	ST-37 (Amec)

Appendix B

Laboratory Test Results and Bedrock Core Photographs

Table B1	Point Load Test Results on Rock Samples
Table B2-1	Summary of Uniaxial Compressive Strength Test Results
Table B2-2	Unconfined Compression Test (UC) – Borehole B502-01, Run No. 1
Table B2-3	Unconfined Compression Test (UC) – Borehole B502-09, Run No. 3
Table B2-4	Unconfined Compression Test (UC) – Borehole B502-11, Run No. 3
Table B2-5	Unconfined Compression Test (UC) – Borehole B502-13, Run No. 2
Figures B1-A to B1-I	Grain Size Distribution – Silt to Sand
Figure B1-J	Grain Size Distribution – Organic Silt to Organic Silt and Sand
Figure B2-A	Plasticity Chart – Organic Silt
Figure B2-B	Plasticity Chart – Silt (Interlayer) to Silt and Sand
Figure B3	Grain Size Distribution – Sand to Sand and Gravel
Figure B4	Plasticity Chart – Organic Silt
Figure B5-A to B5-F	Plasticity Chart – Clayey Silt to Clay
Figure B6	Grain Size Distribution – Clayey Silt
Figure B7	Consolidation Test Summary – Borehole B502-13 SA 10
Figure B8	Consolidation Test Summary – Borehole S502-20 SA 10
Figure B9	Consolidation Test Summary – Borehole S502-20B SA 1
Figure B10	Bedrock Core Photographs – Borehole B502-01, B502-02 and B502-05
Figure B11	Bedrock Core Photographs – Borehole B502-06, B502-07 and B502-09
Figure B12	Bedrock Core Photographs – Borehole B502-10, B502-11 and B502-12
Figure B13	Bedrock Core Photographs – Borehole B502-13, B502-15 and B502-18



PART A

FOUNDATION INVESTIGATION REPORT

STRAIGHT LAKE NBL BRIDGE, SITE NO. 44-461/1

HIGHWAY 69 FOUR-LANING FROM 1.7 KM NORTH OF HIGHWAY 529

NORTHERLY TO 3.9 KM NORTH OF HIGHWAY 522

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 5347-08-00; WP 5145-08-01



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by URS Canada Inc. (URS) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the proposed Highway 69 northbound lane (NBL) bridge over Straight Lake (Site No. 44-461/1) which is within the Contract 5 limits of the new Highway 69 alignment. The proposed work in Contract 5 is part of the overall four-laning of Highway 69 from 1.7 km north of Highway 529 northerly to 3.9 km north of Highway 522, for a total distance of 19.7 km, which includes: high fill embankments and embankments over swamps; the Canadian National Railway (CNR) re-alignment; the Bekanon Road and Highway 522 interchanges and structures; the Still River, Straight Lake and Key River structures; the Canadian Pacific Railway and CNR overpass structures; as well as culvert crossings. The general location of this proposed bridge along the new Highway 69 four-laning alignment is shown on the Index Plan on Drawing 1.

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated December 2008. Golder's proposal (Scope of Work) for foundation engineering services associated with the Contract 5 Straight Lake bridge is contained in Section 6.8 of URS's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated April 19, 2010.

This report addresses the investigation carried out for the Straight Lake NBL bridge only. Separate reports address the foundation investigations for the related swamp crossings and high fill areas, culverts and other bridge structures for the project.

The purpose of this investigation is to establish the subsurface conditions at the proposed bridge location, by borehole drilling, rock coring, in situ testing and laboratory testing on selected soil and rock core samples. The foundation units/limits for this investigation were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by URS. The investigation area is shown in plan on Drawing 2.

Golder completed the investigation for the NBL bridge in the following two phases:

- Phase 1 in 2013: Two boreholes were advanced within Straight Lake along the proposed NBL centreline, at two potential pier locations, following which the investigation was carried out for the high fill area immediately north of Straight Lake (High Fill Swamp 502, reported under separate cover).
- Phase 2 in 2014: The remaining boreholes for the approach embankments and for the bridge were advanced after the span arrangement and location of piers/abutments were established by URS based on preliminary input by Golder from the Phase 1 investigation.

Subsequent to completion of the Phase 2 field investigation in 2014 and a detailed assessment of the subsurface conditions, embankment stability and settlement at the north abutment and approach locations, the layout of the proposed bridge piers was revised and the length of the structure extended to the north. This change to the General Arrangement was agreed upon by MTO, URS and Golder and finalized in February 2016 after detailed comparison of several options to take advantage of more suitable foundation conditions and minimize potential foundation mitigation measures that would otherwise be required for the north abutment and approach embankment. As such, select pertinent boreholes advanced along the proposed NBL centreline within High Fill Swamp 502 north of Straight Lake are also referenced in this report.

Preliminary subsurface information for this project is available and was supplied by the MTO, specifically:



- Preliminary Foundation Investigation and Design Report for Structural Areas (Foundation Investigation 2), Highway 69 Four Laning, From 3.5 km North of Highway 559 to 3.8 km North of Highway 522, GWP 5377-02-00, GEOCRE No. 41H-57, dated July 2006, by Amec Earth and Environmental.

2.0 SITE DESCRIPTION

The proposed Highway 69 alignment is oriented generally in a south-north direction spanning the Township of Wallbridge to the south, the Township of Henvey and the Henvey Inlet First Nation Reserve No. 2 and the Township of Mowat to the north. The Contract 5 section of the new four-lane Highway 69 alignment is also oriented generally in a south-north direction within the overall project limits, for a total distance of about 1.6 km in the Henvey Inlet First Nation Reserve No. 2. The proposed Straight Lake bridge is located approximately 1.1 km east of the existing Highway 69 alignment and 1.5 km from the northern limit of Contract 5, corresponding to approximately 9.0 km north of the junction of the existing Highway 69 and Highway 526.

In general, the topography of this section of the overall project limits consists of rolling terrain, including sparsely or densely treed areas and numerous bedrock outcrops separated by valleys and swamps containing areas of standing water and various types of vegetation and organic soils. At the Straight Lake bridge site, at the south abutment and along the south approach, a bedrock outcrop protrudes from the lake surface (at about Elevation 178 m and extends up to about Elevation 190 m, resulting in an outcrop up to about 12 m high above the lake level. At the north abutment and north approach, the ground surface in the high fill swamp area gradually increases in elevation from the north shore of the lake to the north abutment at Elevation 190.3 m, about 12 m high above the lake level.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The fieldwork for the investigation for High Fill 502 north of Straight Lake and for the Phase 1 bridge investigation, (Boreholes B502-01 and B502-02), was carried out in February, 2013. The fieldwork for the Phase 2 bridge investigation, which includes the remaining B502-series boreholes, was carried out in February and March, 2014. A total of 18 boreholes were advanced for the Phases 1 and 2 bridge investigation, supplemented with a total of 11 boreholes and three DCPTs advanced along the proposed NBL centreline and near each proposed embankment toe in High Fill 502 north of Straight Lake. A summary of the boreholes and their respective locations relative to each foundation element and approach area is presented below. The locations of the boreholes are shown in plan on Drawing 2 and the Record of Borehole/Drillhole sheets are presented in Appendix A.

Foundation Element/Approach Area	Borehole No.
South Approach	B502-03
	B502-04
South Abutment	B502-05
	B502-06
	B502-07
	B502-08



FOUNDATION REPORT – STRAIGHT LAKE NBL BRIDGE
HIGHWAY 69, GWP 5347-08-00, WP 5145-08-01

Foundation Element/Approach Area	Borehole No.
Between South Abutment and Pier 1	B502-09
	B502-15
	B502-16
	B502-17
	B502-18
Pier 1 Area	B502-01
Pier 2 Area	B502-10
	B502-11
Pier 3 Area	B502-02
Between Piers 3 and 4	B502-12
	S502-18
Pier 4 Area	B502-13
North Abutment Area	S502-24
North Approach, including Front Slope	B502-13, B502-14, S502-08, S502-12, S502-18 to S502-20, S502-20A, S502-20B and 502-21 to S502-24, S502-DC02, S502-DC08 and S502-DC09

The field investigation was carried out using a variety of drilling equipment as a result of the varying nature of the terrain and accessibility within the Contract 5 project limits. The details of the drilling equipment and suppliers are listed below.

Drilling Equipment	Supplied and Operated By
Skid Mounted Diedrich D-25	Landcore Drilling of Sudbury, Ontario
Skid Mounted Diedrich D-25	Walker Drilling Ltd. of Utopia, Ontario
Portable Drilling Equipment	OGS Inc. of Almonte, Ontario

The boreholes on land were advanced to depths between 0.1 m (on a bedrock outcrop) and 19.7 m and the boreholes in the lake were advanced to depths of up to 53.4 m below the ice surface, through an ice/water column between 1.2 m and 4.0 m deep.

The boreholes were advanced through the overburden using 150 mm outer diameter (O.D.) solid-stem augers, and 'BW' and/or 'NW' casing with wash boring techniques. In general, soil samples were taken at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm O.D. split-spoon sampler using a manual hammer (rope and cat head) on both the portable and skid-mounted equipment, and carried out in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586). Samples of cohesive soils were obtained at selected locations/depths using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587) for relatively undisturbed samples. Field vane shear tests were carried out in cohesive soils for assessment of undrained shear strengths (ASTM D2573) using MTO Standard 'N' size vanes. Bedrock coring was carried out using an 'NQ' core barrel. Photographs of the recovered rock core samples are provided in Appendix B.



FOUNDATION REPORT – STRAIGHT LAKE NBL BRIDGE
HIGHWAY 69, GWP 5347-08-00, WP 5145-08-01

The groundwater conditions were observed during the drilling operations and all boreholes were backfilled upon completion in accordance with Ontario Regulation 903, Wells (as amended). A standpipe piezometer was installed in each of Boreholes B502-07 and B502-13 to monitor the groundwater level at these locations. The piezometer consists of 32 mm diameter PVC pipe, with slotted screen sealed within the sand to sand and gravel and the sand strata in the respective boreholes. The borehole and annulus surrounding the piezometer pipes above the screen (and sand pack) was backfilled to near the ground surface with bentonite pellets and soil cuttings, topped with a bentonite seal at the ground surface. Piezometer installation details and water level readings are described on the Record of Borehole sheets presented in Appendix A. The water level in the piezometers was measured on March 19, 2014.

The field work was observed by members of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, organic content, grain size distribution and Atterberg limits) was carried out on selected samples. Strength testing, consisting of uniaxial (unconfined) compression and point load index, was carried out on selected specimens of the rock core. The results of the laboratory testing are included in Appendix B.

For the Phase 1 investigation, the proposed centreline of the new highway alignment was staked in the field by Callon Dietz prior to drilling and the as-drilled borehole locations and ground/ice surface elevations were measured/surveyed by a member of our technical staff in reference to the centreline stakes. For the Phase 2 investigation, the boreholes were located in the field and the ground/ice surface elevations were surveyed by Callon Dietz prior to drilling. The locations given on the Record of Borehole/Drillhole sheets and shown on Drawing 2 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum. The borehole locations, ground surface elevations and drilled depths are summarized below.

Borehole No.	Location (MTM NAD 83)		Water/Ground Surface Elevation (Ice/Water Column)* (m)	Borehole Depth (m)
	Northing	Easting		
B502-01	5082947.9	223072.2	178.6*	15.7**
B502-02	5083086.2	223014.2	178.6*	31.8**
B502-03	5082876.8	223101.9	190.2	0.1
B502-04	5082891.5	223090.4	185.7	8.6
B502-05	5082895.1	223088.8	185.7	7.9**
B502-06	5082895.2	223094.2	186.0	9.4**
B502-07	5082895.3	223099.6	186.4	9.8**
B502-08	5082899.0	223098.0	186.3	3.2
B502-09	5082941.3	223074.9	178.6*	6.6**
B502-10	5083001.3	223049.8	178.5*	53.4**
B502-11	5083061.3	223024.7	178.5*	40.3**
B502-12	5083121.2	222999.6	179.3	18.0**
B502-13	5083167.3	222980.3	183.5	18.0**



FOUNDATION REPORT – STRAIGHT LAKE NBL BRIDGE HIGHWAY 69, GWP 5347-08-00, WP 5145-08-01

Borehole No.	Location (MTM NAD 83)		Water/Ground Surface Elevation (Ice/Water Column)* (m)	Borehole Depth (m)
	Northing	Easting		
B502-14	5083185.8	222972.5	186.2	14.8
B502-15	5082935.7	223069.1	178.6*	5.6**
B502-16	5082941.2	223066.8	178.6*	6.9
B502-17	5082941.5	223083.0	178.6*	2.0
B502-18	5082947.0	223080.6	178.6*	10.7**
S502-08	5083197.7	222942.6	190.6	19.7
S502-12	5083243.4	222922.1	192.1	12.5
S502-18	5083149.0	222988.0	181.3	14.7
S502-19	5083170.6	223007.3	180.9	9.8
S502-20	5083172.0	222978.4	184.1	13.5
S502-20A	5083189.5	222993.4	184.2	12.4
S502-20B	5083189.5	222993.9	184.2	6.8
S502-21	5083176.3	222956.2	187.3	16.5
S502-22	5083195.1	222968.7	188.0	18.7
S502-23	5083212.8	222978.6	188.7	16.3
S502-24	5083218.2	222959.0	190.3	17.7
S502-DC02	5083151.2	222966.7	183.4	12.7
S502-DC08	5083189.8	222994.3	184.2	13.0
S502-DC09	5083199.0	222951.4	190.0	20.3

*Ice/Water surface; Borehole Depth includes water column.

**Borehole Depth includes bedrock core length between 1.5 m and 3.6 m.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in The Physiography of Southern Ontario¹, this section of the new Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of relatively shallow deposits of sand, silt and clay underlain by metamorphic bedrock and numerous bare knobs and ridges of bedrock are present throughout the area. Localized low-lying swampy areas, containing peat and/or organic soils overlying soft/loose native soils, sometimes to significant depth, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of crystalline gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario (OGS Special Volume 4)².

¹ Chapman, L.J. and Putnam, D.F., 1984. The Physiography of Southern Ontario, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

² Ontario Geological Society, 1991. Geology of Ontario, Society Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



Deposition of Paleozoic strata initially covered the bedrock and later erosion during glaciation exposed these Precambrian rocks.

4.2 Subsurface Conditions

The detailed subsurface soil, bedrock and groundwater conditions as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil and bedrock core samples, are presented on the Record of Borehole and Drillhole sheets and on the laboratory test figures provided in Appendix A and Appendix B, respectively. The results of the in situ field tests (i.e., SPT 'N'-values and the undrained shear strengths obtained from the field vanes) as presented on the Record of Borehole sheets and in Sections 4.3 to 4.9 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profile and cross-sections are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. The bedrock surface has been inferred from observations made during drilling and coring and generally represents a transition from overburden to the bedrock surface and should not be inferred to represent the exact surface elevation of the bedrock. Furthermore, subsurface conditions will vary between and beyond the borehole locations. It should be noted that the interpreted stratigraphy shown on Drawings 2 to 5 is a simplification of the subsurface conditions.

The subsurface conditions encountered at the site are characterized essentially by:

- At the south abutment/approach: deposits of silt to sand and/or sand and gravel, over granitic gneiss bedrock.
- Within the lake and on the north side of the lake: thick deposits of organic silt, clayey silt to clay, silt to sand, underlain by granitic gneiss bedrock.

The results of the unconfined compressive strength tests on the rock core samples (ASTM D7102 - Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures) are presented in Tables B1 and B2 and the results of the laboratory testing on the soil samples are presented on Figures B1 to B9, in Appendix B. Photographs of the bedrock core samples are presented on Figures B10 to B13, inclusive, in Appendix B.

The quality of the bedrock with respect to the Rock Quality Designation (RQD) value is classified in accordance with Table 3.10 in the Canadian Foundation Engineering Manual (2006)³.

The degree of weathering of the bedrock samples (e.g. slightly weathered – W2) is based on field identification, and the strength classification of the intact rock mass (e.g. strong – R4) is based on laboratory testing of bedrock core samples and is described in accordance with the International Society for Rock Mechanics (ISRM⁴) standard classification system, as presented in Table 3.5 of CFEM (2006).

Axial and diametral point load strength index tests (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classification) were carried out on selected samples of the bedrock core. The axial and diametral point load strength index values are shown on the Record of Drillhole sheets and are presented in Table B1 in Appendix B.

³ Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4th Edition. The Canadian Geotechnical Society c/o BiTech Publisher Ltd, British Columbia.

⁴ International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.



The relationship between I_{s50} and uniaxial compressive strength (UCS) values, given by correlation factor (K), varies depending on the size of the core sample and the strength of the rock. For the NBL (as well as for the SBL) bridge, using the consolidated rock strength data from both sites, an average correlation factor (K) was calculated by matching UCS test values and point load test values at similar depths from the same boreholes. The average correlation factor (K) of 14 was estimated.

A detailed description of the subsurface conditions encountered in the boreholes in the area of each approach/abutment and at/in the area of each pier is provided in the following sections. Borehole B502-09 and Boreholes B502-15 to B502-18 were advanced between the south abutment and Pier 1 and Borehole B502-12 was advanced between proposed Piers 3 and 4 and as these boreholes were not advanced in proximity of the foundation elements, the soil stratigraphy and laboratory test results are presented in this report but are not discussed further in the following sections of the report.

Groundwater and lake water levels are subject to seasonal fluctuations and precipitation events, and should be expected to be higher during wet periods of the year. For the lake boreholes, because the boreholes were advanced in the water, and water was introduced into the boreholes during the drilling process, the water level noted in the boreholes is not considered representative of the stabilized groundwater conditions.

4.3 South Abutment/Approach

A total of six boreholes (B502-03 to B502-08) were advanced in the vicinity of the proposed south abutment/approach. The interpreted stratigraphy at the south approach/abutment is shown in profile on Drawing 2 and in cross-section on Drawing 3.

4.3.1 Topsoil

A 0.1 m to 0.2 m thick layer of topsoil was encountered from ground surface at all the boreholes advanced at the south approach/abutment with the ground surface at Elevation 190.2 m at the south approach (Borehole B502-03) and between Elevations 186.4 m and 185.7 m at the south abutment (Boreholes B502-04 to B502-08).

4.3.2 Silt and Sand to Sand

A 2.3 m to 2.8 m thick deposit of brown to grey silt and sand, silty sand or sand was encountered below the topsoil in Boreholes B502-04 to B502-08 between Elevations 186.2 m and 185.5 m.

The SPT 'N'-values measured within the silt and sand to sand deposit range between 4 blows and 13 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on samples of the deposit range between 8 per cent and 20 per cent.

The results of grain size distribution tests completed on five samples of the silt and sand to sand deposit are shown on Figure B1-A and B1-B in Appendix B.



4.3.3 Organic Silt to Organic Silt and Sand

A 0.2 m to 2.8 m thick deposit of dark brown to black organic silt or organic silt and sand was encountered below the silt and sand to sand in Boreholes B502-04 to B502-08 between Elevations 183.9 m and 182.7 m. Trace roots/wood fragments were encountered within the deposit in Boreholes B502-04 to B502-07.

The SPT 'N'-values measured within the deposit range between 3 blows and 21 blows per 0.3 m of penetration indicating a soft to very stiff consistency.

The natural water content measured on samples of the deposit range between 30 per cent and 65 per cent. The organic content measured on three samples of the deposit is about 4 per cent.

The results of grain size distribution tests completed on four samples of the deposit are shown on Figure B1-J in Appendix B.

Atterberg limits testing carried out on four samples of the organic silt to organic silt and sand yielded liquid limits between about 34 per cent and 44 per cent, plastic limits ranging between about 26 per cent and 31 per cent, and plasticity indices ranging between about 8 per cent and 13 per cent, indicating that the material has slight plasticity attributed to the organic material within the deposit. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2-A.

4.3.4 Silty Sand to Sand and Gravel

A deposit of brown to grey silty sand to sand and gravel was encountered below the organic silt or organic silt and sand deposit in Boreholes B502-04 and B502-06 to B502-08. A 0.8 m thick interlayer of silt was encountered between the upper layer of sand and gravel and the lower layer of silty sand in Borehole B502-04. The silty sand to sand and gravel deposit was encountered between Elevation 183.4 m and 179.9 m, and the thicknesses of the deposit ranges between 0.3 m and 3.6 m. Cobbles were inferred within the deposit at a depth of 6.0 m in Borehole B502-06 and at depths of 3.3 m, 3.9 m and 4.7 m in Borehole B502-07.

The SPT 'N'-values measured within this deposit range between 11 blows and 43 blows per 0.3 m of penetration, and is 10 blows per 0.3 m of penetration within the silt interlayer, indicating a compact to dense relative density. Several SPTs did not penetrate the full test depth, inferred as a result of contact with gravel/cobbles within the deposit.

The natural water content measured on samples of the silty sand to sand and gravel deposit range between 10 per cent and 14 per cent and measured on one sample of the silt interlayer in Borehole B502-04 is 19 per cent.

The result of two grain size distribution tests completed on samples of this deposit is shown on Figure B3.

4.3.5 Bedrock/Refusal

Bedrock core samples were recovered from Boreholes B502-05 to B502-07. Refusal to split-spoon advancement and/or casing refusal was encountered in Boreholes B502-04 and B502-08, while bedrock was exposed underlying the topsoil in Borehole B502-03. The corresponding bedrock surface elevations and refusal are summarized below.



FOUNDATION REPORT – STRAIGHT LAKE NBL BRIDGE
HIGHWAY 69, GWP 5347-08-00, WP 5145-08-01

Foundation Element	Borehole	Bedrock Surface Elevation (m)	Comments
South Approach/Abutment	B502-03	190.1	Exposed Bedrock
	B502-04	177.1	Split-Spoon and Casing Refusal
	B502-05	181.2	Bedrock Cored
	B502-06	178.1	Bedrock Cored
	B502-07	180.1	Bedrock Cored
	B502-08	183.1	Split-Spoon Refusal

In general, the bedrock surface along the south approach and in the area of the proposed south abutment slopes downward from south to north with the bedrock surface elevation changing by as much as 6.0 m at the abutment borehole locations and up to 13.0 m relative to the approach borehole about 20 m south of the abutment.

Based on a review of the bedrock core samples recovered from Boreholes B502-05 to B502-07, the bedrock consists of granitic gneiss. In general the bedrock samples are described as fresh to moderately weathered, grey to dark grey to green to red, foliated, medium to coarse grained, weak to very strong, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photographs of the recovered core samples on Figures B7 and B8 in Appendix B.

The Rock Quality Designation (RQD) measured on the core samples ranges from 30 per cent to 100 per cent, generally indicating a rock mass of poor to excellent quality as per Table 3.10 of CFEM (2006). The Total Core Recovery (TCR) of the samples obtained are between 82 per cent and 100 per cent.

The axial test carried out on six samples of the granitic gneiss bedrock core measured Is_{50} values ranging from 1.4 MPa to 12.7 MPa and the diametral tests carried out on nine samples of the granitic gneiss bedrock core measured Is_{50} values ranging from 2.9 MPa to 10.5 MPa, as presented in Table B1.

Based on the point load tests results at the south abutment, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as weak to very strong (R2 to R5, 5 MPa < UCS < 250 MPa).

4.3.6 Groundwater Conditions

Borehole B502-03 was dry upon completion of drilling. The groundwater level in Boreholes B502-04 to B502-06 and B502-08, upon completion of drilling was measured between Elevation 184.1 m and 183.4 m, at depths between 2.2 m and 2.3 m below ground surface.

A standpipe piezometer was installed in Borehole B502-07 to allow monitoring of the groundwater level at the borehole location. Details of the piezometer installation are shown on the Record of Borehole sheet in Appendix A and the groundwater level measured in the piezometer is summarized below.

Foundation Element	Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
South Abutment	B502-07	186.4	182.7	March 19, 2014



4.4 Pier 1 Area

A total of six boreholes (B502-01, B502-09 and B502-15 to B502-18) were advanced south of the proposed Pier 1. The interpreted stratigraphy at Borehole B502-01 located about 8 m south of Pier 1 is shown in cross-section on Drawing 3 and the interpreted stratigraphy perpendicular to the centreline of the foundation area south of Pier 1 is also shown on Drawing 3. The boreholes encountered variable depth of water, variable overburden thickness and bedrock surface steeply sloping to the north. The following section presents the results of Borehole BH502-01, which is the closest borehole to Pier 1 relative to the remaining boreholes.

4.4.1 Ice/Water

The ice surface at Borehole B502-01 in Straight Lake in February 2013 was at Elevation 178.6 m and the depth of ice/water was 4.0 m.

4.4.2 Organic Silt

A deposit of organic silt was encountered below the water in Borehole B502-01 with the top of the deposit encountered at Elevation 174.6 m and the thickness of the deposit is 4.8 m.

The SPT 'N'-values measured within the organic deposit are 0 blows (weight of rod) per 0.3 m of penetration suggesting a very soft consistency; and two in situ field vane tests carried out near the bottom of the organic silt deposit measured undrained shear strengths of 9 kPa and 14 kPa, with corresponding sensitivities of 1 and 2, indicating a very soft consistency.

The natural water content measured on a sample of the deposit is 135 per cent. The organic content measured on two samples of the deposit are about 9 per cent and 12 per cent.

An Atterberg limits test carried out on one sample of the organic deposit yielded a liquid limit of 62 per cent, a plastic limit of 45 per cent, corresponding to a plasticity index of 17 per cent, indicating that the material is classified as an organic silt of high plasticity. The result of the Atterberg limits test is shown on the plasticity chart on Figure B4.

4.4.3 Upper Silt

A 1.1 m thick deposit of grey silt was encountered below the organic silt at Elevation 169.8 m in Borehole B502-01.

One SPT 'N'-value measured within the deposit is 1 blows per 0.3 m of penetration indicating a very loose relative density.

The natural water content measured a sample of the deposit is about 24 per cent.

4.4.4 Clayey Silt

A 1.9 m thick deposit of grey clayey silt was encountered below the upper silt deposit in at Elevation 168.7 m in Borehole B502-01.



One SPT 'N'-value measured within the clayey silt deposit is 1 blow per 0.3 m of penetration. Two in situ field vane tests carried out within the clayey silt measured undrained shear strengths of 20 kPa and 35 kPa, indicating a soft to firm consistency and corresponding to sensitivities of 2 and 4.

The natural water content measured on a sample of the deposit is 46 per cent.

Atterberg limits tests carried out on a sample of the clayey silt yielded a liquid limit of 31 per cent, a plastic limit of 18 per cent, corresponding to a plasticity index of 13 per cent, indicating that the material is classified as clayey silt of low plasticity. The results of the Atterberg limits test are shown on the plasticity chart on Figure B5-A.

4.4.5 Lower Silt

A 0.9 m thick deposit of grey silt was encountered below the clayey silt deposit at Elevation 166.8 m in Borehole B502-01.

One SPT 'N'-value measured within the deposit is 6 blows per 0.3 m of penetration indicating a loose relative density.

The natural water content measured a sample of the deposit is about 29 per cent.

The result of one grain size distribution test completed on a sample of the deposit is shown on Figure B1-A.

4.4.6 Bedrock/Refusal

Bedrock was encountered and core samples were recovered from Borehole B502-01 at Elevation 165.9 m.

In general, the bedrock surface in the area of the proposed Pier 1 slopes down from south to north based on Boreholes B502-09 and B502-15 to B502-18 further to the south and Borehole B502-10 to the north of the pier.

Based on a review of the bedrock core samples recovered from the boreholes, the bedrock consists of granitic gneiss. In general the bedrock samples are described as fresh to slightly weathered, medium to coarse grained, strong, grey, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered core samples on Figures B7.

The RQD measured on two core samples is 94 per cent and 96 per cent, indicating the rock is of excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples ranges from 94 per cent to 100 per cent.

The point load strength index axial tests carried out on two samples of the granitic gneiss bedrock core measured Is_{50} values of 8.0 MPa and 6.9 MPa and the diametral tests carried out on three samples of the granitic gneiss bedrock core measured Is_{50} values ranging from 9.9 MPa to 14.3 MPa, as presented in Table B1.

One UCS test (ASTM D7012) carried out on a selected sample of the granitic gneiss bedrock measured a uniaxial compressive strength of about 68 MPa as summarized in Table B2-1 and detailed in Tables B2-2, respectively, in Appendix B.

Based on the UCS and point load test results on bedrock core samples from the Pier 1 area, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as strong to very strong (R4 to R5, 50 MPa < UCS < 250 MPa).



4.5 Pier 2 Area

Boreholes B502-10 and B502-11 were advanced about 25 m south and 40 m north of the proposed Pier 2. The stratigraphy in Borehole B502-10 is shown in cross-section on Drawing 4.

4.5.1 Ice/Water

The ice surface at Boreholes B502-10 and B502-11 in Straight Lake in February 2014 is Elevation 178.5 m, and the depth of ice/water is 3.9 m and 1.8 m, respectively.

4.5.2 Organic Silt to Clayey Organic Silt

A 4.1 m thick deposit of dark grey organic silt was encountered below the water in Borehole B502-10 with the top of the deposit at Elevations 174.6 m. A 4.4 m thick deposit of dark grey clayey organic silt deposit was encountered below the water in Borehole B502-11 at Elevation 176.7 m.

The SPT 'N'-values measured within the organic silt to clayey organic silt are 0 blows (weight of rod) per 0.3 m of penetration, suggesting a very soft consistency.

The natural water content measured on samples of the deposit range between 114 per cent and 189 per cent. The organic content measured on two samples of the clayey organic silt is about 6 per cent.

4.5.3 Clayey Silt to Clay with Silt and Sand to Silty Sand Interlayers

A 13.0 m and 15.1 m thick deposit of grey to brown clayey silt to clay, with interlayers of sandy silt, silt and sand and silty sand, was encountered below the organic silt deposit in Boreholes B502-10 and B502-11 at Elevation 170.5 m and 172.3 m, respectively. In Borehole B502-10, the two interlayers of silt and sand, and silty sand were encountered at Elevations 167.1 m and 164.0 m, and are 1.7 m and 1.5 m thick, respectively. In Borehole B502-11, the two interlayers of sandy silt and silty sand were encountered at Elevations 167.8 m and 163.3 m, and the thicknesses of the layers is 1.5 m and 1.0 m, respectively. The lower portion of the clay deposit contains silt seams between the depths of 16.0 m and 21.3 m. Reportedly, Amec's Borehole ST-37 encountered occasional cobbles and a possible boulder at about approximate Elevation 166 m.

The SPT 'N'-values measured within the clayey silt to clay deposit range between 1 blow and 6 blows per 0.3 m of penetration. In situ field vane tests carried out within the deposit measured undrained shear strengths ranging between 15 kPa and 67 kPa, suggesting a soft to stiff consistency with corresponding sensitivities between 3 and 13. One vane test within the upper clayey silt zone in Borehole B502-10 measured an undrained shear strength greater than 96 kPa, likely as a result of the interface with the underlying silt and sand interlayer.

The SPT 'N'-values measured within the sandy silt, silt and sand, and silty sand interlayers are between 5 blows and 18 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on samples of the clayey silt to clay range from 25 per cent to 54 per cent. The natural water content measured on two samples of the silt and sand and sandy silt interlayers is 16 per cent and 19 per cent.



The results of two grain size distribution test completed on samples of the silt and sand and sandy silt interlayers are shown on Figure B1-B.

Atterberg limits testing carried out on five samples of the clayey silt to clay deposit yielded liquid limits between 20 per cent and 59 per cent, plastic limits between 14 per cent and 19 per cent, with plasticity indices between 7 per cent and 40 per cent, indicating that the material is classified as a clayey silt of low plasticity (upper zone) to a clay of high plasticity (lower zone). The results of the Atterberg limits tests are shown on the plasticity chart on Figure B5-A.

4.5.4 Silt

An 8.0 m and 9.2 m thick deposit of grey silt was encountered below the clayey silt to clay deposit in Boreholes B502-10 and B502-11 at Elevation 157.5 m and 157.2 m, respectively. In Borehole B502-11, a cobble was inferred present within the deposit from auger grinding at a depth of 29.0 m, corresponding to Elevation 149.5 m.

The SPT 'N'-values measured within the silt range between 6 blows and 26 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on samples of the deposit range between 22 per cent and 32 per cent.

The results of three grain size distribution tests completed on samples of the silt deposit are shown on Figures B1-B and B1-C.

Atterberg limits testing carried out on three samples of the silt deposit indicates that the material is non-plastic.

4.5.5 Silty Sand to Sand

A 16.6 m thick deposit of grey sand was encountered below the silt in Borehole B502-10 at Elevation 149.5 m. In Borehole B502-11, a 6.3 m thick deposit of grey silty sand was encountered below the silt at Elevation 148.0 m. In Borehole B502-10, gravel and cobbles were encountered within the deposit at a depth of 36.3 m, corresponding to Elevation 142.2 m. In Borehole B502-11, a cobble was encountered at a depth of 31.7 m, corresponding to Elevation 146.8 m and a sandy silt pocket was encountered at a depth of 36.7 m, corresponding to Elevation 141.8 m.

The SPT 'N'-values measured within the silty sand to sand deposit range between 13 blows and 24 blows per 0.3 m of penetration indicating a compact relative density.

The natural water content measured on two samples of the deposit are 19 per cent and 23 per cent.

The results of one grain size distribution test completed on a sample of the silty sand is shown on Figure B1-D and that of a sample of the sandy silt pocket is shown on Figure B1-C. The results of two grain size distribution tests completed on a sample of the sand are shown on Figure B3.



4.5.6 Cobbles and Boulders

A 1.2 m thick deposit of cobbles and boulders was encountered in Borehole B502-10 at Elevation 132.9 m. Reportedly, Amec's Borehole ST-37 encountered occasional cobbles and a possible boulder at about approximate Elevation 166 m.

4.5.7 Sandy Gravel

A 3.4 m thick deposit of grey sandy gravel was encountered below the cobbles and boulders in Borehole B502-10 at Elevation 131.7 m. Cobbles were encountered within the deposit at a depth of 49.8 m, corresponding to Elevation 128.7 m.

One SPT 'N'-value measured within the deposit is 19 blows per 0.3 m of penetration indicating a compact relative density.

The natural water content measured on one sample of the deposit is 6 per cent.

4.5.8 Bedrock

In Boreholes B502-10 and B502-11, bedrock was encountered at Elevation 128.3 m and 141.7 m, respectively, and core samples were recovered from both boreholes.

Based on a review of the bedrock core samples recovered from Boreholes B502-10 and B502-11, the bedrock consists of granitic gneiss. In general the bedrock samples, as presented in the Record of Drillhole sheets in Appendix A and as shown on the photograph of the recovered core samples on Figure B12 in Appendix B, are described as slightly weathered, foliated, medium grained, weak to very strong and grey with pink bands.

The RQD measured on the core samples ranges between 67 per cent and 100 per cent, indicating the rock is of fair to excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples ranges from 93 per cent to 100 per cent.

The point load strength index axial tests carried out on seven samples of the granitic gneiss bedrock core measured Is_{50} values ranging from 1.7 MPa to 9.4 MPa and the diametral tests carried out on five samples of the granitic gneiss bedrock core measured Is_{50} values ranging from 0.3 MPa to 10.1 MPa, as presented in Table B1.

One UCS test carried out on a selected core sample of the granitic gneiss bedrock obtained in Borehole B502-11 measured a compressive strength of about 23 MPa as summarized in Table B2-1 and detailed in Table B2-4, in Appendix B.

Based on the UCS and point load test results of the bedrock core samples from the vicinity of Pier 2, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as weak rock to very strong (R2 to R5, 5 MPa < UCS < 250 MPa).

4.6 Pier 3 Area

Borehole B502-02 was advanced about 8 m south of the proposed Pier 3. The stratigraphy in Borehole B502-02 is shown in cross-section on Drawing 4.



4.6.1 Ice / Water

The ice surface at Borehole B502-02 in Straight Lake in February 2013 was measured at Elevation 178.6 m, and the depth of ice/water was 1.4 m.

4.6.2 Peat

A 0.7 m thick deposit of dark brown peat was encountered below the ice/water at Elevation 177.2 m in Borehole B502-02.

One SPT 'N'-value measured within the peat is 0 blows (i.e., weight of rod) per 0.3 m of penetration indicating a very soft relative density.

The natural water content measured on a sample of the deposit is 598 per cent. The organic content measured on one sample of the peat is about 30 per cent.

4.6.3 Organic Silt

A 2.3 m thick deposit of dark brown to dark grey organic silt was encountered below the peat in Borehole B502-02 at Elevation 176.5 m.

The SPT 'N'-values measured within the organic silt deposit are 0 blows (weight of rod) per 0.3 m of penetration, suggesting a very soft consistency. Two in situ field vane tests carried out within the organic silt deposit measured undrained shear strengths of 8 kPa and 10 kPa, suggesting a very soft consistency, with corresponding sensitivities of 2 and 3.

The organic content measured on one sample of the organic silt is about 13 per cent.

4.6.4 Clayey Silt to Clay

A 16.4 m thick deposit of grey clayey silt to silt clay was encountered in Borehole B502-02 below the organic silt at Elevation 174.2 m. An interlayer of silt and sand were encountered within the cohesive deposit at Elevation 168.7 m, and the thicknesses of the layer is 1.4 m. The clayey silt to silty clay deposit contains silt seams throughout.

The SPT 'N'-values measured within the clayey silt to silty clay deposit range between 1 blow and 15 blows per 0.3 m of penetration. In situ field vane tests carried out within the clayey silt to silty clay deposit measured undrained shear strengths ranging between 45 kPa and greater than 96 kPa, suggesting a soft to stiff consistency, with corresponding sensitivities between 2 and 10.

One SPT 'N'-value measured within the silt and sand interlayer is 1 blow per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on samples of the clayey silt to silty clay deposit ranges from 30 per cent to 68 per cent. The natural water content measured on one sample of the silt and sand interlayer is 21 per cent.



The result of the grain size distribution tests completed on two samples of the clayey silt portion of the deposit are shown on Figure B6. The result of one grain size distribution test completed on a sample of the silt and sand interlayer is shown on Figure B1-D.

Atterberg limits testing carried out on five samples of the clayey silt to silty clay deposit yielded liquid limits ranging between 18 per cent and 41 per cent, plastic limits ranging between 13 per cent and 20 per cent, and plasticity indices of ranging between 5 per cent and 23 per cent, indicating that the material is classified as a clayey silt of low plasticity to a silty clay of intermediate plasticity. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B5-D.

4.6.5 Silt

A 5.6 m thick deposit of grey silt was encountered at Elevation 157.8 m in Borehole B502-02.

Two SPT 'N'-values measured within the silt deposit are 10 blows and 17 blows per 0.3 m of penetration, indicating a compact relative density.

The natural water content measured on two samples of the deposit is 23 per cent.

The result of one grain size distribution test completed on a sample of the silt is shown on Figure B1-D.

Atterberg limits testing carried out on one sample of the silt deposit indicates that the material is non-plastic.

4.6.6 Gravelly Silt and Sand

A 1.6 m thick deposit of grey gravelly silt and sand was encountered at Elevation 152.2 m in Borehole B502-02.

An SPT 'N'-value measured within the gravelly silt and sand deposit is 36 blows per 0.3 m of penetration, indicating a dense relative density.

The natural water content measured on a sample of the deposit is 18 per cent.

The results of one grain size distribution test completed on a sample of the gravelly silty sand deposit is shown on Figure B1-E.

4.6.7 Cobbles and Boulders

A 0.5 m thick layer of cobbles and boulders was encountered at Elevation 150.6 m.

4.6.8 Bedrock

Bedrock was encountered at Elevation 150.1 m and core samples were recovered in Borehole B502-02.

Based on a review of the bedrock core samples recovered from the borehole, the bedrock consists of granitic gneiss. In general the bedrock samples, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered core samples on Figure B10 in Appendix B, are described as slightly weathered to fresh, medium to coarse grained, very strong and grey with light pink bands.



The RQD measured on the core samples ranges between 71 per cent and 96 per cent, indicating the rock is of fair to excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples ranges from 97 per cent to 100 per cent.

The point load strength index axial tests carried out on three samples of the granitic gneiss bedrock core measured Is_{50} values ranging from 9.4 MPa and 10.8 MPa and the diametral tests carried out on three samples of the granitic gneiss bedrock core measured Is_{50} values of 5.6 MPa and 8.9 MPa, as presented in Table B1.

Based on the point load test results of the bedrock core samples from Pier 3, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as strong to very strong (R4 to R5, 50 MPa < Pt. Load Index < 250 MPa).

4.7 Pier 4 Area

Borehole B502-13 was advanced about 5 m north of the proposed Pier 4. The stratigraphy at Borehole B502-13 is shown in cross-section on Drawing 5.

4.7.1 Topsoil

A 0.2 m thick deposit of topsoil was encountered from ground surface at Elevation 183.5 m in Borehole B502-13.

4.7.2 Silt

A 0.3 m thick deposit of grey silt was encountered below the topsoil in Borehole B502-13 at Elevation 183.3 m.

4.7.3 Sand

A 5.0 m thick deposit of grey sand was encountered below the silt layer in Borehole B502-13 at Elevation 183.0 m.

SPT 'N'-values measured within the deposit range between 2 blows and 12 blows per 0.3 m of penetration indicating a very loose to compact relative density.

The natural water content measured on three samples of the sand deposit ranges from about 22 per cent to 26 per cent.

The results of a grain size distribution test carried out on a sample of the sand deposit is shown on Figure B1-C.

4.7.4 Clayey Silt to Silty Clay

A 5.0 m thick deposit of grey clayey silt to silty clay was encountered below the sand deposit at Elevation 178.0 m in Borehole B502-13.

Two SPT 'N'-values measured within the clayey silt to silty clay deposit are 1 blow and 4 blows per 0.3 m of penetration. In situ field vane tests carried out within the clayey silt to silty clay deposit measured undrained shear



strengths ranging between 35 kPa and 42 kPa, and the sensitivity ranges between 6 and 9. The results of the field vane tests indicate that the clayey silt to silty clay deposit has a firm consistency.

The natural water content measured on samples of the clayey silt to silty clay deposit ranges between 32 per cent and 41 per cent.

Atterberg limits tests carried out on three samples of the clayey silt to silty clay deposit yielded liquid limits ranging between about 25 per cent and 42 per cent, plastic limits ranging between about 13 per cent and 18 per cent and plasticity indices ranging between about 13 per cent and 25 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B5-B, and indicate that the material is classified as a clayey silt of low plasticity to a silty clay of intermediate plasticity.

A laboratory consolidation test was completed on a sample of the cohesive deposit from Borehole B502-13 and the results are discussed in Section 4.9.5 (North Approach) as the test results are relevant to the approach embankment front slope rather than the pier.

4.7.5 Silt

A 4.0 m thick deposit of grey silt was encountered at Elevation 173.0 m underlying the clayey silt to silty clay deposit in Borehole B502-13.

SPT 'N'-values measured within the silt deposit range between 4 blows and 10 blows per 0.3 m of penetration indicating a loose to compact relative density.

The natural water content measured on two samples of the deposit is 22 per cent.

The result of a grain size distribution test carried out on a sample of the silt deposit is shown on Figure B1-C.

4.7.6 Boulder

A 0.3 m thick boulder was encountered between the silt deposit and the underlying bedrock at Elevation 169.0 m in Borehole B502-13.

4.7.7 Bedrock

Bedrock was encountered at Elevation 168.7 m and core samples were recovered from Borehole B502-13.

Based on a review of the bedrock core samples recovered from Borehole B502-13, the bedrock consists of granitic gneiss. In general the bedrock samples, as presented in the Record of Drillhole sheets in Appendix A, and shown on the photograph of the recovered core samples on Figure B13 in Appendix B are described as slightly weathered, fine to medium grained, very strong and dark grey with pink bands.

The RQD measured on the two core samples is between 100 per cent and 87 per cent, indicating rock of good to excellent quality, according to Table 3.10 in CFEM (2006). The TCR for the core samples was 100 per cent.

The point load strength index diametral tests carried out on two samples of the granitic gneiss bedrock core measured Is_{50} values of 7.2 MPa and 7.5 MPa, as presented in Table B1.

One UCS test (ASTM D7012) carried out on a selected sample of the granitic gneiss bedrock obtained in Borehole B502-13 measured a UCS of about 111 MPa as summarized in Table B2-1 and detailed in Table B2-5, in Appendix B.



Based on the point load strength index and the UCS test results of the bedrock core sample from the Pier 4 area, in accordance with Table 3.5 in CFEM (2006), the granitic gneiss bedrock is classified as very strong (R4 to R5, 50MPa < UCS < 250 MPa).

4.7.8 Groundwater Conditions

A standpipe piezometer was installed in Borehole B502-13 sealed within the sand deposit to allow monitoring of the groundwater level at this location. Details of the piezometer installation are shown on the Record of Borehole sheet in Appendix A and the groundwater level measured in the piezometer is summarized below.

Foundation Element	Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
Pier 4	B502-13	183.5	182.1	March 19, 2014

4.8 North Abutment

Borehole S502-24 was advanced approximately 4.9 m south of the proposed north abutment. The interpreted stratigraphy near the north abutment is shown in cross-section on Drawing 5.

4.8.1 Topsoil

A 0.8 m thick layer of topsoil was encountered at ground surface at Elevation 190.3 m in Borehole S502-24.

One SPT 'N'-value measured with the topsoil is 3 blows per 0.3 m of penetration, suggesting a soft consistency.

The natural water content measured on a sample of the topsoil is 67 per cent and the organic content measured on the same sample of the topsoil is about 6 per cent.

4.8.2 Silt to Sand with Clay Interlayer

A 16.9 m thick deposit comprised of layers of brown to grey sand, silt and sand, and silt was encountered below the topsoil at Elevation 189.5 m in Borehole S502-24. A 1.8 m thick clay interlayer was encountered between an overlying sand layer and an underlying silt layer at Elevation 178.6 m.

The SPT 'N'-values measured within the overall silt to sand deposit range between 0 blows (weight of hammer) and 17 blows per 0.3 m of penetration indicating a very loose to compact relative density.

One SPT 'N'-value measured with the clay interlayer was 1 blow per 0.3 m of penetration. One in situ field vane test carried out within the clay interlayer measured an undrained shear strength of about 25 kPa and a sensitivity of 5. The result of the field vane test indicates that the clay interlayer has a firm consistency.

The natural water content measured on samples of the silt to sand deposit ranges between 8 per cent and 29 per cent. The natural water content measured on one sample of the clay interlayer is 50 per cent.

The results of four grain size distribution tests completed on samples of the various layers of the silt to sand deposit from Borehole S502-24 are shown on Figure B1-F.

The results of Atterberg limits tests carried out on one sample of the silt and the silt and sand layers of the deposit indicate that the materials are non-plastic.



4.8.3 Refusal

Refusal to further split spoon and auger advancement was encountered at Elevation 172.6 m in Borehole S502-24, at a depth of 17.7 m below ground surface.

4.8.4 Groundwater Conditions

In Borehole S502-24, the water level upon completion of drilling was measured at a depth of 6.0 m below ground surface (Elevation 184.3 m).

4.9 North Approach

A total of 13 boreholes (Boreholes B502-13, B502-14, S502-08, S502-12, S502-18 to S502-24, S502-20A and S502-20B) three DCPTs (S502-DC02, S502-DC08 and S502-DC09) were advanced in the area of the north approach embankment, including the front slope area of the north abutment. Borehole S502-20B was advanced adjacent to Borehole B502-20A to obtain a Shelby Tube sample of the cohesive deposit. The interpreted stratigraphy at the north approach is shown in profile on Drawing 2.

4.9.1 Peat/Topsoil

A 0.3 m and 0.4 m thick layer of fibrous peat was encountered at the ground surface in Boreholes S502-18 and S502-19 and an approximately 0.2 m to 0.8 m thick layer of topsoil was encountered at the ground surface in Boreholes B502-13, B502-14, S502-08, S502-12, S502-18 to S502-24 and S502-20A. The surface of the peat/topsoil layers ranges between Elevations 192.1 m and 180.9 m.

An SPT 'N'-value of 3 blows and 2 blows per 0.3 m of penetration was measured within the topsoil deposit and peat deposit in Boreholes S502-24 and S502-19, respectively, suggesting a soft consistency.

The natural water content measured on a two samples of the topsoil is about 67 per cent and 68 per cent.

The organic content measured on a sample of the topsoil is about 6 per cent.

4.9.2 Organic Silt

An approximately 0.8 m thick deposit of organic silt was encountered below the peat deposit in Boreholes S502-19 at Elevation 180.5 m.

An SPT 'N'-value of 2 blows per 0.3 m of penetration was measured at the interface with the underlying deposit of the clayey silt in Borehole S502-19, suggesting that the organic silt has a soft consistency.

4.9.3 Clayey Silt to Silty Clay (Pockets/Interlayers)

Boreholes B502-14, S502-08, S502-12, S502-18, S502-19, S502-20A, S502-21 and S502-22 penetrated various layers/pockets of cohesive soils comprised of clayey silt to silty clay ranging in thickness between about 0.5 m and 1.5 m below the peat/topsoil/organic silt layers and/or within the non-cohesive silt and sand to sand deposit. The pockets/layers encountered below the topsoil/peat generally contain trace organics. The top of the cohesive pockets/layers ranges between Elevations 191.9 m and 179.8 m.



SPT 'N'-values ranging from 0 blows (weight of hammer) to 7 blows per 0.3 m of penetration were measured within the cohesive soil pockets/layers. In situ field vane tests carried out within the cohesive pocket in Boreholes B502-14 and S502-08 measured undrained shear strengths of about 39 kPa and 62 kPa and sensitivity values of 5. The SPT 'N'-values and field vane test results suggest that the cohesive soil pockets/layers have a very soft to stiff consistency.

The natural water content measured on seven samples of the cohesive soil pockets ranges from about 18 per cent to 38 per cent.

A grain size distribution test result for a sample from the cohesive soil pocket from Borehole S502-20A is shown on Figure B6 in Appendix B.

Atterberg limits tests were carried out on six samples from the cohesive soil pockets and measured liquid limits ranging from about 24 per cent to 42 per cent, plastic limits ranging from about 15 per cent to 24 per cent and plasticity indices ranges from about 8 per cent to 19 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figures B5-B to B5-F in Appendix B and indicate that the material is classified as clayey silt of low plasticity to silty clay of intermediate plasticity.

4.9.4 Silt to Sand (Upper Deposit)

An upper deposit of brown to grey silt to silt and sand to silty sand to sand, trace to some silt was encountered below the topsoil layer in Boreholes B502-13, B502-14, S502-20, S502-20A, S502-21 and S502-24 and underlying the cohesive soil pockets in Boreholes S502-08, S502-18, S502-12, S502-22 and S502-23. The non-cohesive deposit generally contains trace to some clay and trace to some gravel and occasional pockets/layers of clayey silt up to about 1.5 m thick. The top of this deposit is at Elevation 191.0 m at the north limit of the site decreasing to Elevation 180.5 m near the south limit of the site. The overall thickness of the deposit ranges from 2.9 m at the south limit (Borehole S502-18) to 10.9 m at the north limit of the from slope area (Borehole S502-24), respectively, and is about 3.0 m thick in the north approach area (Borehole S502-12).

The SPT 'N'-values measured within the non-cohesive deposit range from 0 blows (weight of hammer) to 20 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit ranges from about 7 per cent to 31 per cent.

The results of grain size distribution tests completed on 19 samples from this deposit are shown on Figures B1-C to B1-I in Appendix B.

Atterberg limits tests were carried out on two (2) samples of the fines portion from the silt to silt and sand of this deposit and measured liquid limits of about 16 per cent and 15 per cent, plastic limits of about 14 per cent and corresponding plasticity indices of about 2 per cent and 1 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B2-B in Appendix B and indicate that the fines portion of the deposit is a silt of slight plasticity.

4.9.5 Clayey Silt to Clay

A deposit of brown to grey clayey silt to silty clay to clay was encountered below the organic silt or below the silt to sand deposit in Boreholes B502-13, B502-14, S502-08, S502-12, S502-20A and S502-18 to S502-24. The deposit contains silt to silty sand layers/pockets about 0.2 m and 0.5 m thick in Boreholes S502-19 and S502-22, respectively. The top of the cohesive deposit ranges between Elevations 187.8 m and 174.2 m and the overall



thickness of the deposit varies between 0.3 m at the north limit (Borehole S502-24) and 7.4 m at the south limit (Borehole S502-18), including the thickness of the non-cohesive layers/pockets.

The SPT 'N'-values measured within this deposit range from 0 blows (weight of hammer) to 7 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from 23 kPa to greater than 62 kPa but generally greater than 25 kPa, indicating a soft to stiff consistency. The sensitivity of the cohesive deposit ranges from 2 to 10.

The natural water content measured on samples of this deposit ranges from about 23 per cent to 65 per cent.

Atterberg limits tests carried out on 22 samples of the cohesive deposit measured liquid limits ranging from about 22 per cent to 55 per cent, plastic limits ranging from about 13 per cent to 22 per cent and plasticity indices ranging from about 4 per cent to 36 per cent. The results of the Atterberg limits tests are shown on the plasticity charts on Figures B5-B to B5-F in Appendix B and indicate that the material is classified as a clayey silt of low plasticity to a clay of high plasticity.

Laboratory consolidation tests were carried out on three specimens of the silty clay portion of the cohesive deposit obtained from Shelby tube samples in Boreholes B502-13, S502-20 and S502-20B. Preconsolidation stresses ranging from about 150 kPa and 195 kPa were estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. Bulk unit weights ranging from about 16.9 kN/m³ to 17.6 kN/m³ and specific gravities of about 2.75 and 2.76 were measured on the consolidation test specimens. Details of the test results are shown on Figures B7 to B9 in Appendix B, and the test results are summarized below.

Borehole Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	C_c	C_r	e_o	c_v^* (cm ² /s)
Borehole B502-13 Sample 10	7.7 m / 175.8 m	75	160	85	2.1	0.62	0.06	1.24	4.6×10^{-4}
Borehole S502-20 Sample 10	9.4 m / 174.7 m	100	150	50	1.5	0.79	0.02	1.40	7.2×10^{-4}
Borehole S502-20B Sample 1	5.7 m / 178.5 m	55	195	140	3.5	0.80	0.06	1.43	1.0×10^{-3}

Note: * For stress range between effective overburden stress and final stress due to a 4.4 m high embankment, that is $40 \text{ kPa} \leq \sigma_v' \leq 185 \text{ kPa}$.

where: σ_{vo}' is the in situ vertical effective overburden stress in kPa
 σ_p' is the preconsolidation stress in kPa
 OCR is the overconsolidation ratio
 e_o is the initial void ratio
 C_c is the compression index
 C_r is the recompression index
 c_v is the coefficient of consolidation in cm²/s

4.9.6 Silt to Sand (Lower Deposit)

A lower deposit of grey silt to sand was encountered underlying the cohesive deposit in Boreholes B502-13, B502-14, S502-08, S502-12, S502-18 to S502-24 and S502-20A. The deposit generally contains trace to some clay and trace gravel. A 0.3 m boulder was encountered at the bottom of the deposit in Boreholes B502-13 at Elevation 169.0 m. The top of this deposit ranges from about Elevation 176.8 m at the north limit of the front slope (Borehole S502-24) to about Elevation 172.5 m towards the south limit or toe of the front slope (Borehole B502-14)



and the thickness of the deposit ranges from 0.9 m to 5.3 m. At Borehole S502-12, at the toe of the North Approach Embankment slope the surface of this deposit is at Elevation 187.5 m and the thickness of the deposit is 7.9 m. The bottom of this deposit is defined by refusal to further casing and/or split-spoon advancement in Boreholes B502-14, S502-08, S502-12, S502-18 to S502-24 and S502-20A.

The SPT 'N'-values measured within this deposit range from 0 blows (weight of rod) per 0.3 m of penetration to 18 blows per 0.15 m of penetration, indicating a very loose to compact relative density, with one SPT 'N'-value measured in the sand in Borehole S502-20A at 50 blows per 0.15 m of penetration, indicating a very dense relative density.

The natural water content measured on samples of this deposit ranges from about 19 per cent to 25 per cent.

The results of grain size distribution tests completed on 15 samples of the deposit are shown on Figure B1-C to B1-I in Appendix B.

Atterberg limits tests were carried out on eight samples of the silt to silt and sand deposit. The results of seven of the Atterberg limits tests indicate that the fines portions of the silt to sand deposit are non-plastic and the other Atterberg limits test measured a liquid limit of about 17 per cent, a plastic limit of about 16 per cent and a plasticity index of about 1 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure B2-B in Appendix B indicating that the silt layer of the overall deposit exhibits slight plasticity.

4.9.7 Bedrock / Refusal

In Boreholes B502-14, S502-08, S502-12, S502-18 to S502-24 and in DCPTs S502-DC01, S502-DC02, S502-DC04, S502-DC08 and S502-DC09 the bedrock surface is inferred by refusal to further split-spoon and/or auger advancement or dynamic cone penetration at depths between about 9.8 m and 20.7 m below the ground surface, between Elevations 179.6 m and 160.8 m. Refusal was encountered at shallower depths near the north limit of the front slope/approach embankment area and the greatest depths to refusal were encountered near the south limit of the high fill area adjacent to the north shore of Straight Lake.

The bedrock encountered in Borehole B502-13 advanced near the toe of the front slope area in the vicinity of Pier 4 is described in Section 4.7.7.

4.9.8 Groundwater Conditions

The depth to the groundwater level measured in the open boreholes, upon completion of drilling range from 0.3 m to 7.6 m below ground surface or between Elevations 184.5 m and 178.9 m, with the groundwater table generally located closer to the ground surface in the southern portion of the north approach (front slope area).

A standpipe piezometer was installed in Borehole B502-13 to allow monitoring of the groundwater level at the borehole location. Details of the piezometer installation are shown on the Record of Borehole sheet in Appendix A and the groundwater level measured in the piezometer is summarized below.

Foundation Element	Borehole	Ground Surface Elevation (m)	Groundwater Elevation (m)	Date of Measurement
North Approach (Front Slope/Pier Area)	B502-13	183.5	182.1	March 19, 2014



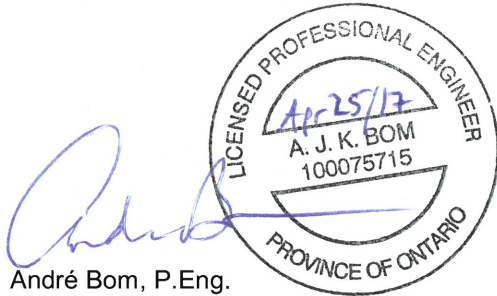
5.0 CLOSURE

The drilling program was directed by Mike Arthur, Indulis Dumpis, Trevor Moxam and Mat Riopelle. This report was prepared by Mr. Matt Thibeault, P.Eng., and reviewed by Mr. André Bom, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M. A. Costa, P.Eng., Golder's Designated MTO Contact for this project and a Senior Consultant with Golder, conducted an independent quality control review of the report.



Report Signature Page

GOLDER ASSOCIATES LTD.



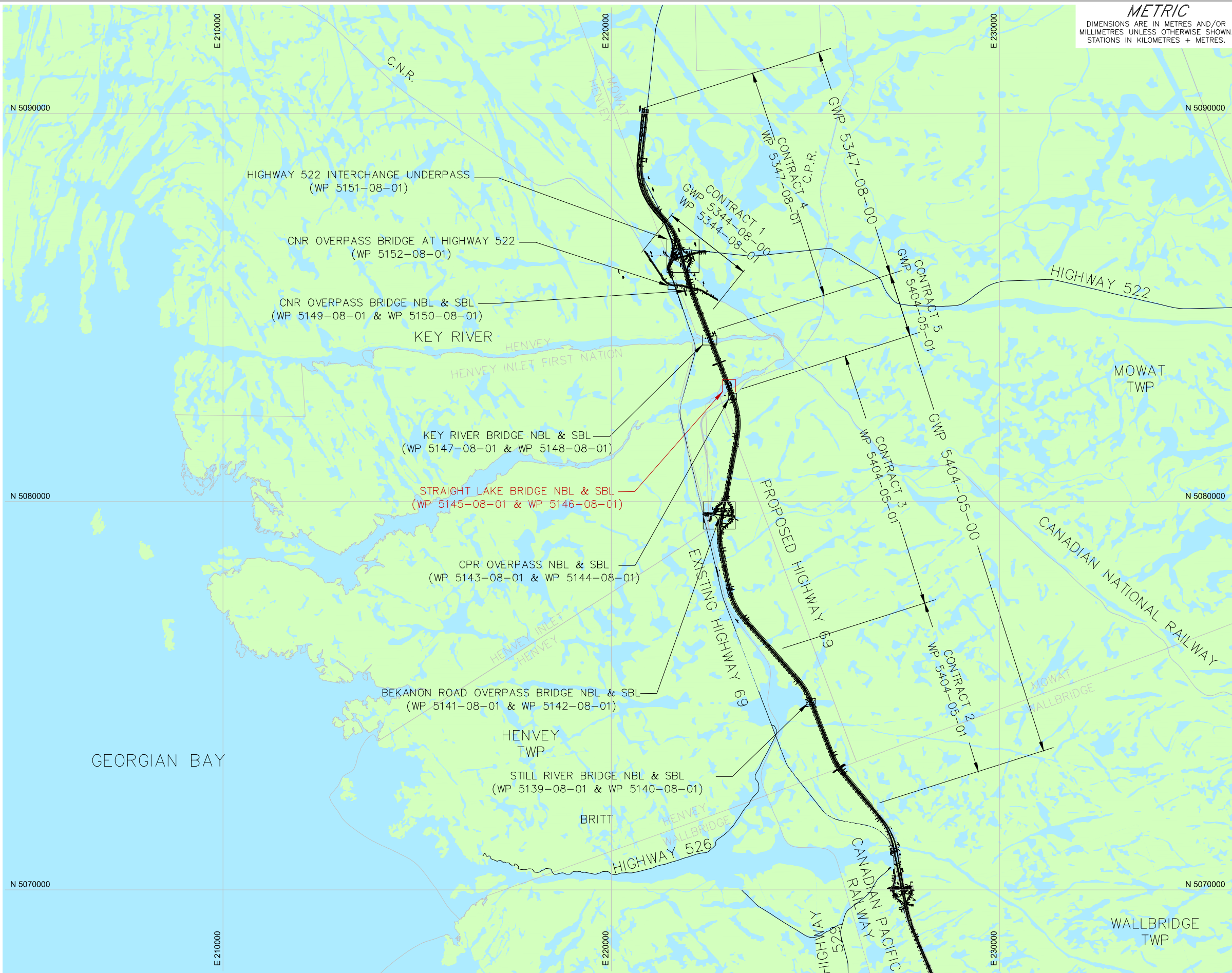
André Bom, P.Eng.
Senior Geotechnical Engineer, Associate



Jorge M.A. Costa, P. Eng.
Designated MTO Foundations Contact, Senior Consultant

MT/AB/JPD/JMAC/kp

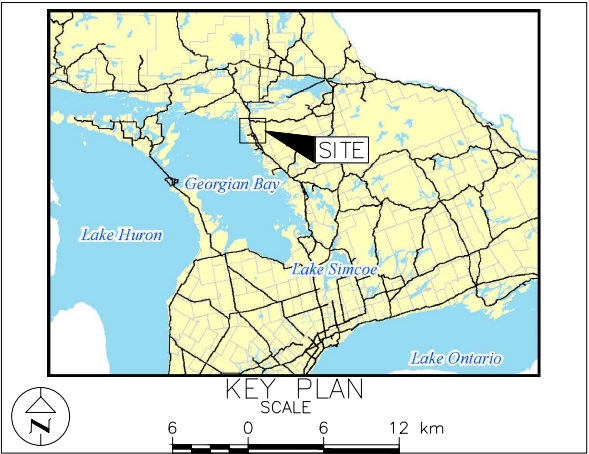
N:\Active\2009\1190 Sudbury\09-1111-6014 Straight Lake Contract 5\Straight Lake\NBL\Final\09-1111-6014 RPT 17Apr25 Highway 69 - Straight Lake NBL FIDR.docx



METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.	WP No.
	5145-08-01
HIGHWAY 69 STRAIGHT LAKE NBL BRIDGE	
INDEX PLAN	

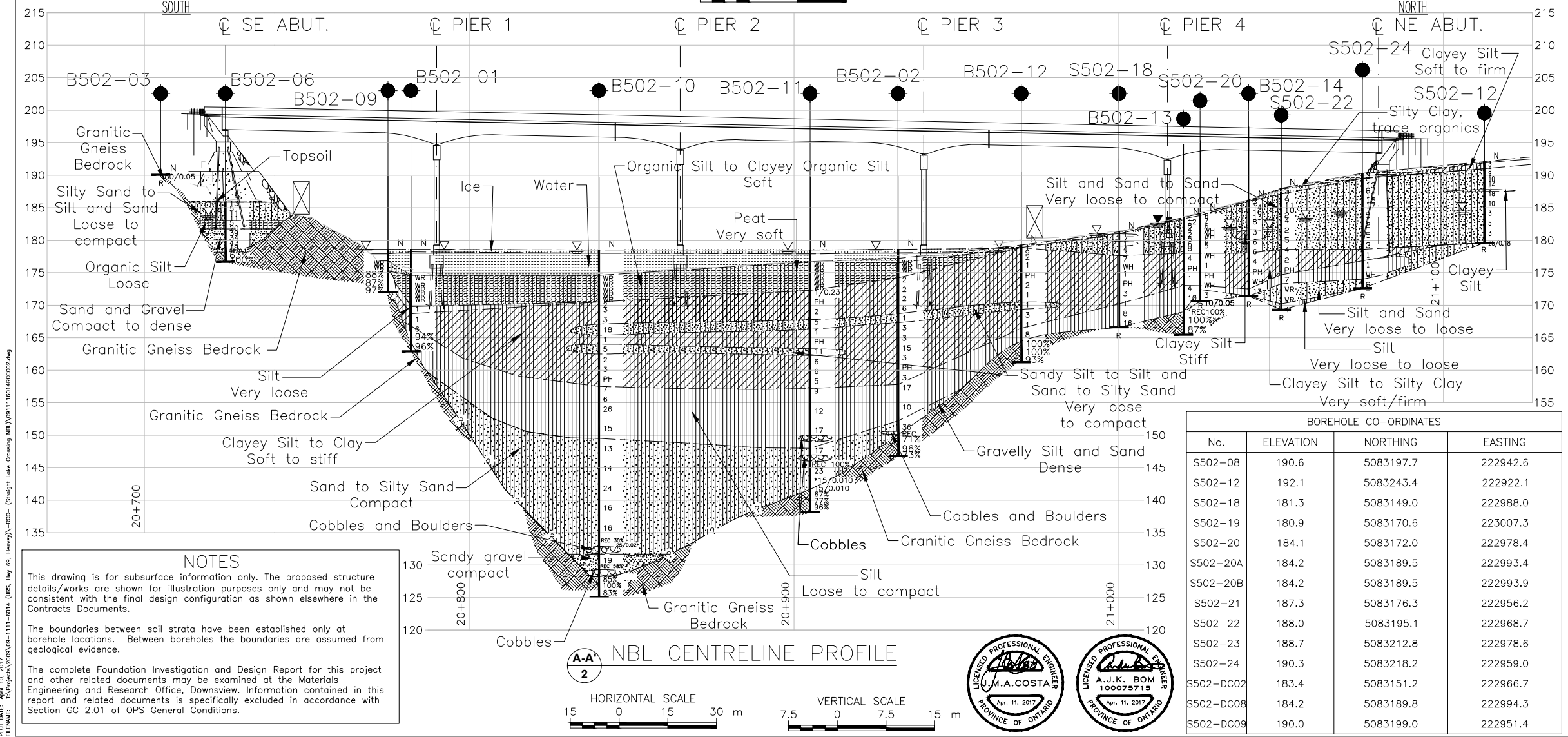
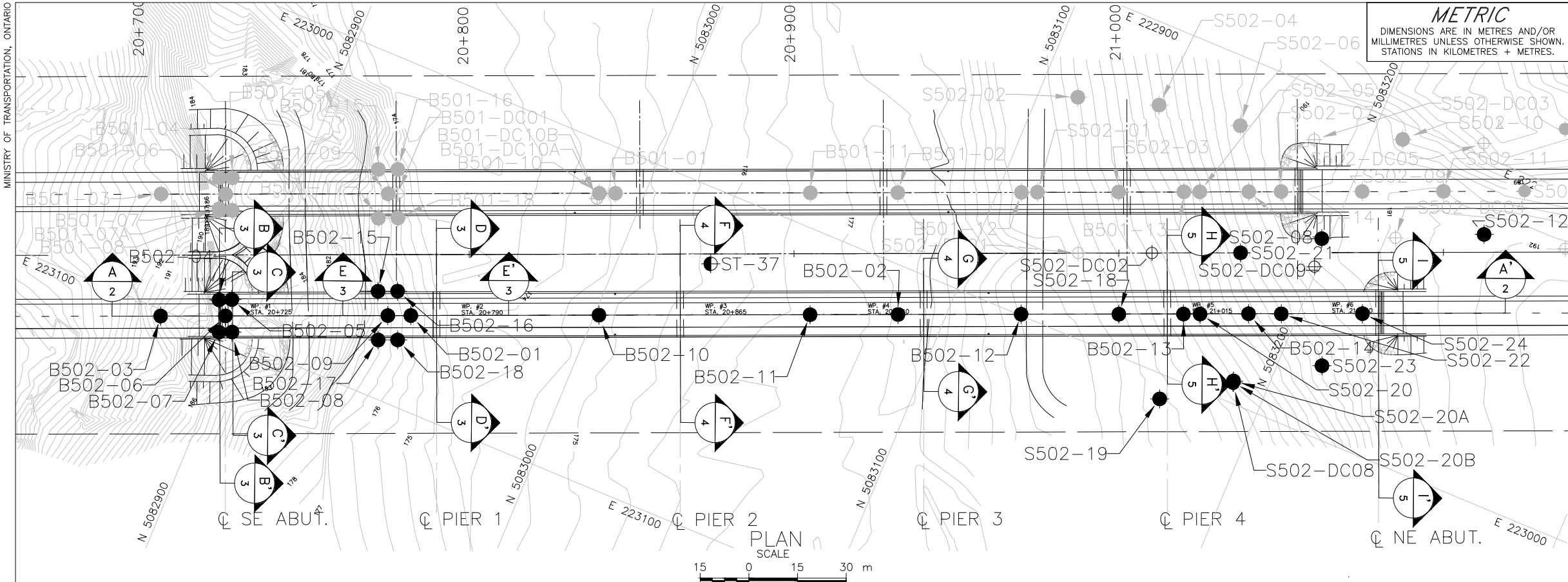
SHEET



PLAN



REFERENCE			
Base Data - MNR NRVIS, obtained 2004, CANMAP v2008 Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, ©Queens Printer 2008 Datum : NAD 83 Projection : MTM Zone 10			
NO.	DATE	BY	REVISION
Geocres No. 41H-165			
HWY. 69		PROJECT NO. 09-1111-6014	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: July 2015	SITE: 44-461/1
DRAWN: JFC	CHKD. AB	APPD. JMAC	DWG. 1



CONT No.
WP No. 5145-08-01

HIGHWAY 69
STRAIGHT LAKE NBL BRIDGE
BOREHOLE LOCATIONS AND
SOIL STRATA

KEY PLAN
SCALE
6 0 6 12 km

LEGEND

●

Borehole - Current Investigation

⊕

Dynamic Cone Penetration Test

●

Borehole - Previous Investigation (AMEC)

N

Standard Penetration Test Value

R

Refusal

16

Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)

100%

Rock Quality Designation (RQD)

▽

WL in piezometer (March 8/14)

▽

WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
B502-01	178.6	5082947.9	223072.2
B502-02	178.6	5083086.2	223014.2
B502-03	190.2	5082876.8	223101.9
B502-04	185.7	5082891.5	223090.4
B502-05	185.7	5082895.1	223088.8
B502-06	186.0	5082895.2	223094.2
B502-07	186.4	5082895.3	223099.6
B502-08	186.3	5082899.0	223098.0
B502-09	178.6	5082941.3	223074.9
B502-10	178.5	5083001.3	223049.8
B502-11	178.5	5083061.3	223024.7
B502-12	179.3	5083121.2	222999.6
B502-13	183.5	5083167.3	222980.3
B502-14	186.2	5083185.8	222972.5
B502-15	178.6	5082935.7	223069.1
B502-16	178.6	5082941.2	223066.8
B502-17	178.6	5082941.5	223083.0
B502-18	178.6	5082947.0	223080.6

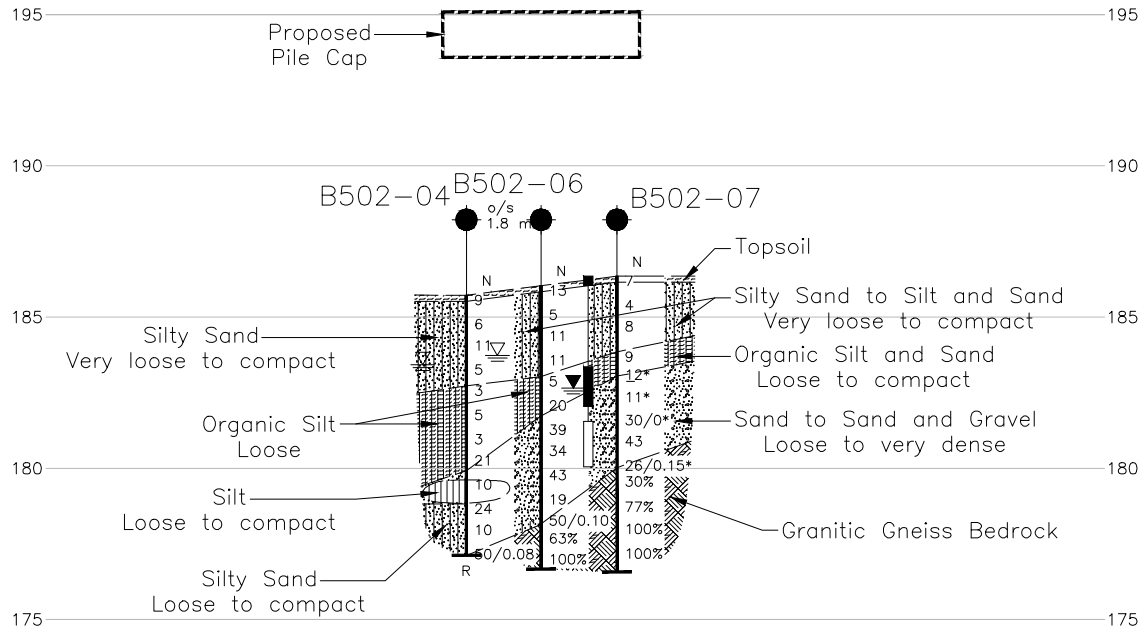
REFERENCE

Base plans provided in digital format by URS, drawing file nos. Contours from Hwy69_Contour-Plan_C5.dwg, received August 31, 2012, KEY RIVER CROSSING OPTION B_Northbound_GA.dwg and KEY RIVER CROSSING OPTION B_Southbound_GA.dwg, received November 4, 2013. Bridge General Arrangement Plan and Profile provided in digital format by AECOM, drawing file nos. GA_NBL_StraightLakeCrossing.dwg and GA_SBL_StraightLakeCrossing.dwg, received Jan. 6, 2017.

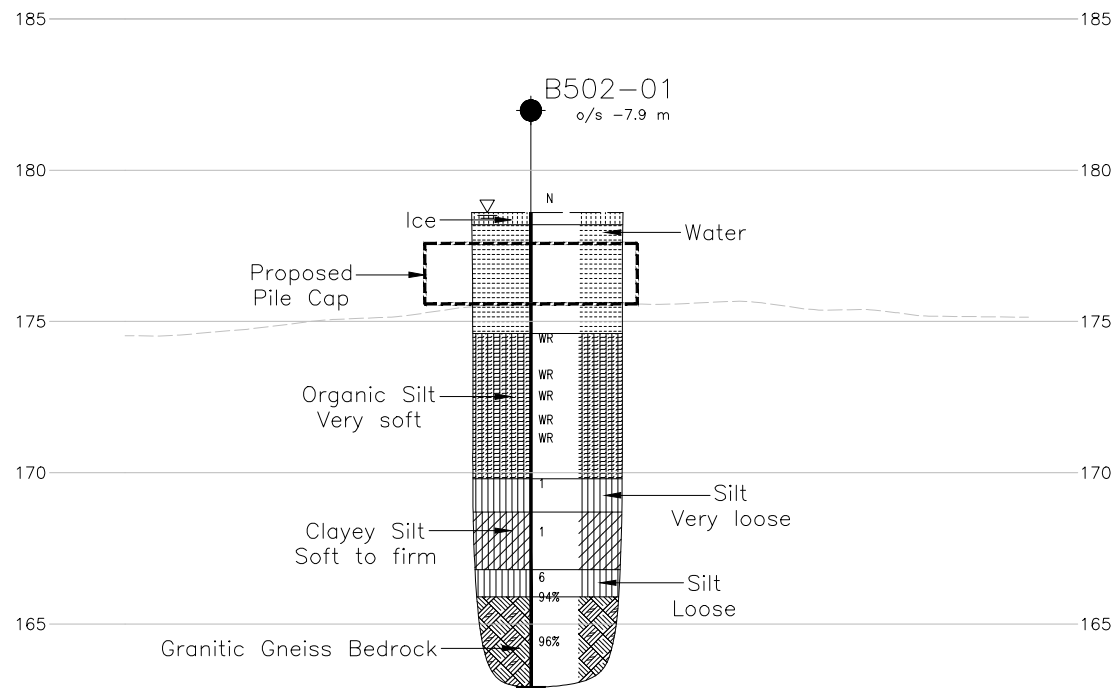
Geocres No. 41H-165

HWY. 69	PROJECT NO. 09-1111-6014	DIST.
SUBM'D. MCK	CHKD. AB	DATE: Nov 2015
DRAWN: JFC/MR	CHKD. AB	APPD. JMAC
		DWG. 2

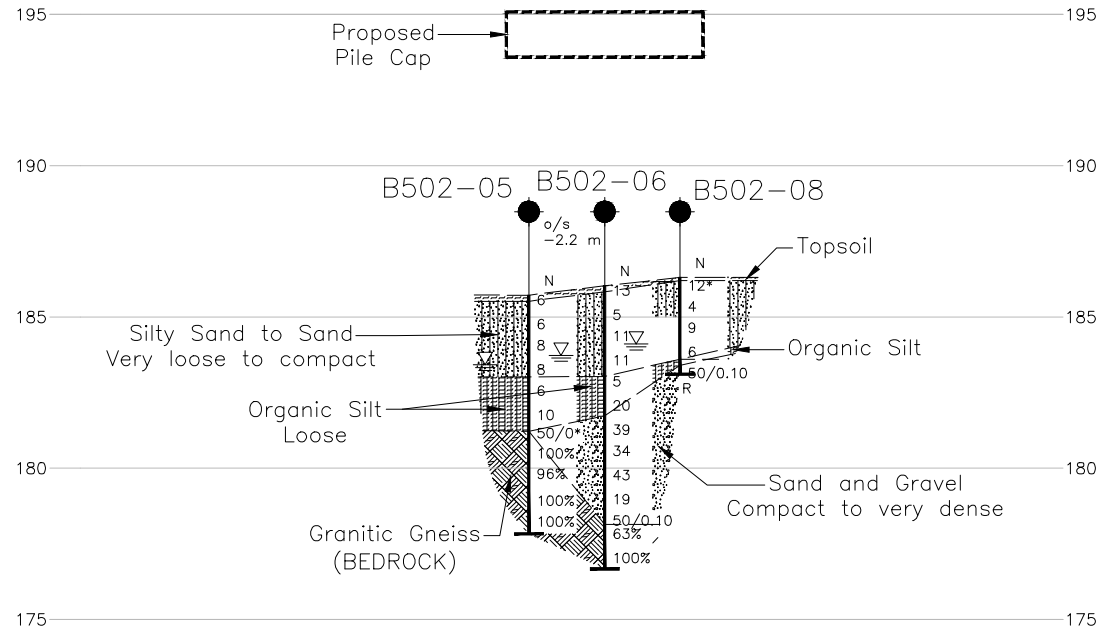
DATE: April 13, 2017
FILENAME: T:\Project\2009-09-1111-6014 (URS, Hwy 69, Henry)\-RCC- (Straight Lake Crossing NBL)\0911116014RCC002.dwg



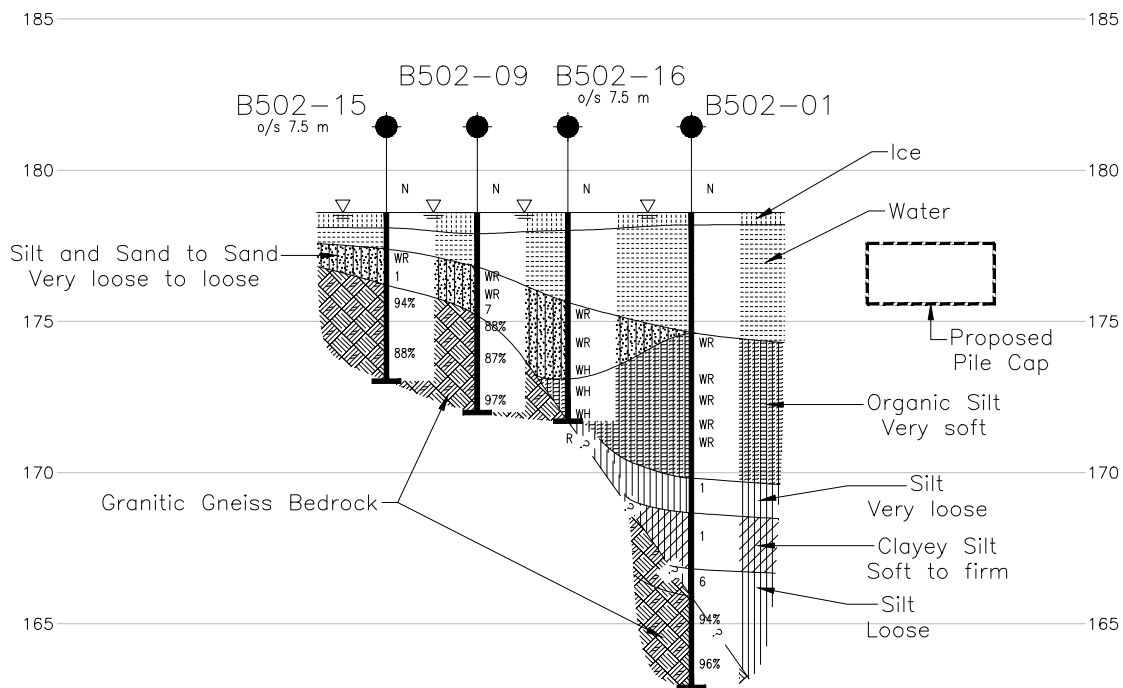
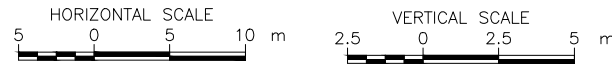
B-B'
1 NBL SOUTH ABUTMENT CROSS-SECTION B-B'



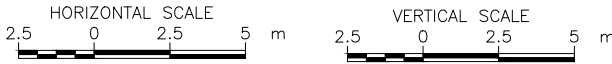
D-D'
1 NBL PIER 1 AREA CROSS-SECTION D-D'



C-C'
1 NBL SOUTH ABUTMENT CROSS-SECTION C-C'



E-E'
1 NBL PIER 1 AREA CROSS-SECTION E-E'

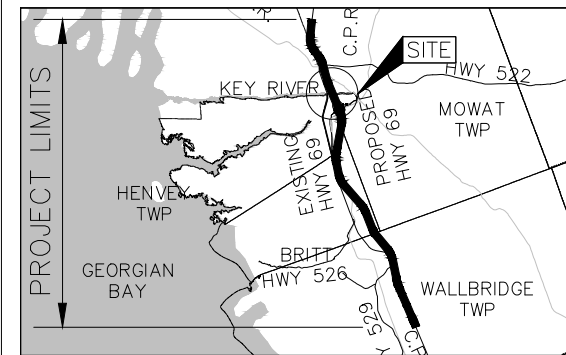


METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. .
WP No. 5145-08-01

HIGHWAY 69
STRAIGHT LAKE NBL BRIDGE
SOIL STRATA

SHEET



KEY PLAN
SCALE
0 6 12 km

LEGEND

- Borehole - Current Investigation
- ⬮ Seal
- ⬮ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- ▽ WL in piezometer, measured on March 19, 2014
- ▽ WL upon completion of drilling
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
B502-01	178.6	5082947.9	223072.2
B502-04	185.7	5082891.5	223090.4
B502-05	185.7	5082895.1	223088.8
B502-06	186.0	5082895.2	223094.2
B502-07	186.4	5082895.3	223099.6
B502-08	186.3	5082899.0	223098.0
B502-09	178.6	5082941.3	223074.9
B502-15	178.6	5082935.7	223069.1
B502-16	178.6	5082941.2	223066.8

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

NO.	DATE	BY	REVISION
Geocres No. 41H-165			
HWY. 69		PROJECT NO. 09-1111-6014	
SUBM'D. MCK		CHKD. .	DATE: Nov 2015
DRAWN: JFC/MR		CHKD. AB	APPD. JMAC
DIST. .		SITE: 44-461/1	
		DWG. 3	







HIGHWAY 69
STRAIGHT LAKE NBL BRIDGE
SOIL STRATA



**Golder
Associates**



- | | |
|---|--|
|  | Borehole – Current Investigation |
| N | Standard Penetration Test Value |
| 16 | Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow) |
| 100% | Rock Quality Designation (RQD) |
|  | WL upon completion of drilling |
| REC | Recovery |

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B502-02	178.6	5083086.2	223014.2
B502-10	178.5	5083001.3	223049.8

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

	-	-							
NO.	DATE	BY	REVISION						
Geocres No. 41H-165									
HWY. 69			PROJECT NO. 09-1111-6014					DIST. .	
SUBM'D. MCK			CHKD. .	DATE: Nov. 2015			SITE: 44-461 /		
DRAWN: JFC			CHKD. AB	APPD. JMAC			DWG. 4		

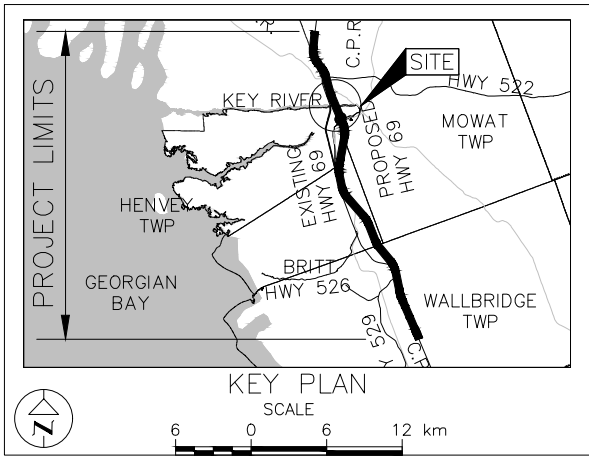
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. .
WP No. 5145-08-01

HIGHWAY 69
STRAIGHT LAKE NBL BRIDGE

SOIL STRATA

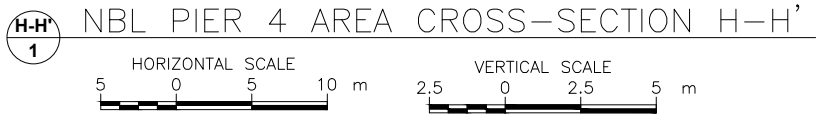
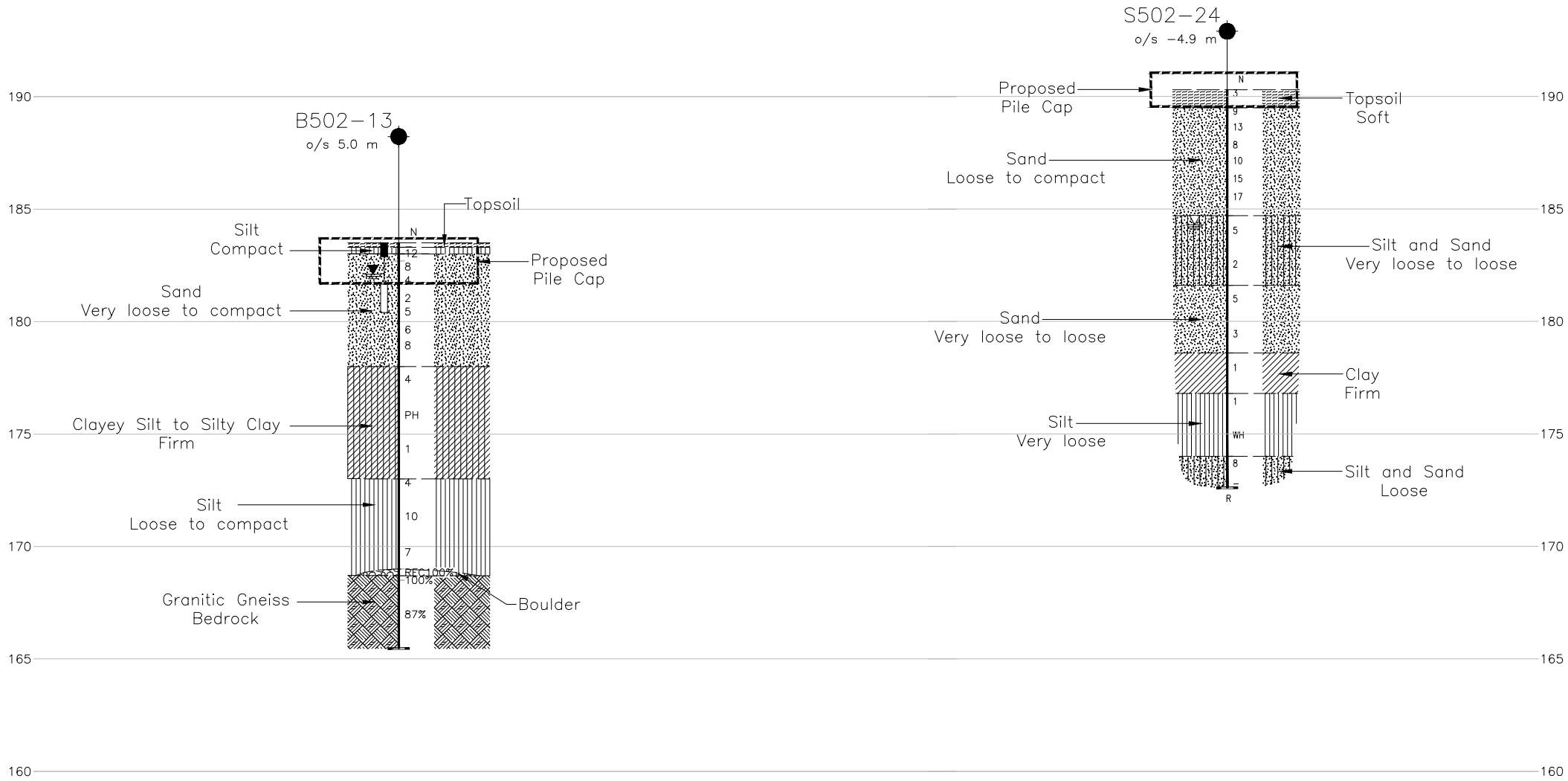
SHEET



LEGEND

- Borehole - Current Investigation
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer, measured on March 19, 2014
- WL upon completion of drilling
- REC Recovery

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
B502-13	183.5	5083167.3	222980.3
S502-24	190.3	5083218.2	222959.0



NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.



Geocres No. 41H-165			
HWY. 69	PROJECT NO. 09-1111-6014		DIST. .
SUBM'D. MCK	CHKD. .	DATE: Nov. 2015	SITE: 44-461/1
DRAWN: JFC	CHKD. AB	APPD. JMAC	DWG. 5



APPENDIX A

Record of Borehole and Drillhole Sheets



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a)	Index Properties
$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$$\tau = c' + \sigma' \tan \phi'$$

$$\text{shear strength} = (\text{compressive strength})/2$$



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Split-spoon
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

(b) Cohesive Soils Consistency

	<u>kPa</u>	<u>C_u, S_u</u>	<u>psf</u>
Very soft	0 to 12		0 to 250
Soft	12 to 25		250 to 500
Firm	25 to 50		500 to 1,000
Stiff	50 to 100		1,000 to 2,000
Very stiff	100 to 200		2,000 to 4,000
Hard	over 200		over 4,000

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

w	water content
w _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

V. MINOR SOIL CONSTITUENTS

Per cent by Weight	Modifier	Example
0 to 5	Trace	Trace sand
5 to 12	Trace to Some (or Little)	Trace to some sand
12 to 20	Some	Some sand
20 to 30	(ey) or (y)	Sandy
over 30	And (non-cohesive (cohesionless)) or With (cohesive)	Sand and Gravel Silty Clay with sand / Clayey Silt with sand



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90° angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN Joint	PL Planar
FLT Fault	CU Curved
SH Shear	UN Undulating
VN Vein	IR Irregular
FR Fracture	K Slickensided
SY Stylolite	PO Polished
BD Bedding	SM Smooth
FO Foliation	SR Slightly Rough
CO Contact	RO Rough
AXJ Axial Joint	VR Very Rough
KV Karstic Void	
MB Mechanical Break	

PROJECT		RECORD OF BOREHOLE		No B502-01		SHEET 1 OF 2		METRIC							
W.P. 09-1111-6014		LOCATION		N 5082947.9 ; E 223072.2		ORIGINATED BY		MA							
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring, NQ Coring		COMPILED BY							
DATUM		Geodetic		DATE		February 20 to 21, 2013		CHECKED BY							
								AB							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
178.6	ICE SURFACE														
0.0	ICE														
178.2															
0.4	WATER														
174.6															
4.0	ORGANIC SILT Very soft Dark brown to dark grey Wet		1	SS	WR										
			2	SS	WR										
			3	SS	WR										
			4	SS	WR										
			5	SS	WR										
169.8															
8.8	SILT, some sand, with silty clay seams Very loose Grey Wet		6	SS	1										
168.7															
9.9	CLAYEY SILT Soft to firm Grey Wet		7	SS	1										
166.8															
11.8	SILT, trace sand, trace clay Loose Grey Wet		8	SS	6										
165.9															
12.7	Granitic Gneiss (BEDROCK)														
	Bedrock cored from depths of 12.6 m to 15.7 m.		1	RC	REC 94%										
	For bedrock coring details refer to Record of Drillhole B502-01.		2	RC	REC 100%										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: WALKER DRILLING

CHECKED: AB



METRIC

ORIGINATED BY MA

COMPILED BY MCK

CHECKED BY AB

+3, ×3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE




METRIC

CHECKED BY AB

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-02				SHEET 3 OF 3		METRIC										
W.P. 5145-08-01		LOCATION N 5083086.2 ; E 223014.2				ORIGINATED BY MA												
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring				COMPILED BY MCK												
DATUM Geodetic		DATE February 26 to 28, 2013				CHECKED BY AB												
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa										
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					20 40 60 WATER CONTENT (%)						
146.8	Granitic Gneiss (BEDROCK)		3	RC	REC 100%	148											RQD = 96%	
31.8	Bedrock cored from depths of 28.5 m to 31.8 m. For bedrock coring details refer to Record of Drillhole B502-02.		4	RC	REC 97%	147											RQD = 73%	
	END OF BOREHOLE																	

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B502-02

SHEET 1 OF 1

LOCATION: N 5083086.2 ;E 223014.2

DRILLING DATE: February 28, 2013

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D55

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate												BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage												PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular												PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough												MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.												NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
								TOTAL CORE %	SOLID CORE %									10	10	10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
																							10	10	10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
																										10	10	10																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
29	NW Casing	Continued from Record of Borehole B502-2 Slightly weathered to fresh, thinly laminated to thinly bedded, medium to coarse grained, dark grey with light pink bands, very strong to extremely strong, GRANITIC GNEISS		150.10	2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

DEPTH SCALE

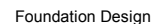
1 : 50



LOGGED: MA

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16



+3, ×3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-04		SHEET 1 OF 1		METRIC														
W.P. 5145-08-01		LOCATION N 5082891.5 ; E 223090.4		ORIGINATED BY TM																
DIST _____ HWY 69		BOREHOLE TYPE BW Casing, Wash Boring		COMPILED BY MCK																
DATUM Geodetic		DATE March 12, 2014		CHECKED BY AB																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L	20 40 60	OC = 3.7%						
185.7	GROUND SURFACE																			
0.0	TOPSOIL																			
0.2	SILT and SAND, trace to some clay Loose to compact Light brown Moist to wet		1	SS	9		185													
			2	SS	6															
			3	SS	11		184										0 55 41 4			
			4	SS	5		183													
182.7	ORGANIC SILT with wood fragments and roots and with silty sand layers (about 50 mm to 75 mm thick) between 4.7 m and 5.8 m Soft to very stiff Dark brown to black Wet		5	SS	3		182													
			6	SS	5															
			7	SS	3		181													
			8A	SS	21		180													
179.9	SAND and GRAVEL, trace silt Compact Grey Wet		9	SS	10		179													
179.6	SILT, some sand Loose to compact Grey Wet		10	SS	24		178													
178.8	Silty SAND, some gravel, trace clay Loose to compact Grey Wet		11	SS	10															
			12	SS	50/0.08												17 51 29 3			
177.1	END OF BOREHOLE SPLIT-SPOON AND CASING REFUSAL																			
8.6	NOTE: 1. Water level in open borehole at a depth of 2.3 m below ground surface (Elev. 183.4 m) upon completion of drilling.																			

PROJECT		RECORD OF BOREHOLE		No B502-05		SHEET 1 OF 1		METRIC									
W.P. 09-1111-6014		LOCATION		N 5082895.1 ; E 223088.8		ORIGINATED BY		TM									
DIST		HWY 69		BOREHOLE TYPE		BW Casing, Wash Boring, Thin Wall NQ Coring		COMPILED BY									
DATUM		Geodetic		DATE		March 12, 13 and 14, 2014		CHECKED BY									
								AB									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
185.7	GROUND SURFACE							20	40	60	80	100					
0.0	TOPSOIL																
0.2	Silty SAND, trace clay Loose Light brown Moist		1	SS	6												
			2	SS	6												
			3	SS	8												
	Becoming wet below a depth of 2.3 m.		4A	SS	8												
183.0	ORGANIC SILT with wood fragments and roots Firm to stiff Dark brown Wet		4B	SS	6												
2.7			5	SS	6												
			6	SS	10												
181.2	Granitic Gneiss (BEDROCK)		7	SS	50 - 11												
4.5	Bedrock cored from depths of 4.5 m to 7.9 m. For bedrock coring details refer to Record of Drillhole B502-05.		1	RC	REC 100%												
			2	RC	REC 96%												
			3	RC	REC 100%												
			4	RC	REC 100%												
177.8	END OF BOREHOLE																
7.9	NOTE: 1. Water level in open borehole at a depth of 2.3 m below ground surface (Elev. 183.4 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: OGS DRILLING

CHECKED: AB

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-06		SHEET 1 OF 1		METRIC															
W.P. 5145-08-01		LOCATION N 5082895.2 ; E 223094.2		ORIGINATED BY TM																	
DIST HWY 69		BOREHOLE TYPE BW Casing, Wash Boring, Thin Wall NQ Coring		COMPILED BY MCK																	
DATUM Geodetic		DATE March 15 and 18, 2014		CHECKED BY AB																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p W W _L			γ	GR	SA	SI	CL	
186.0	GROUND SURFACE							20 40 60 80 100													
0.0	TOPSOIL																				
0.2	Silty SAND to SILT and SAND, trace clay Loose to compact Brown Moist to wet		1	SS	13		185														
			2	SS	5																
			3	SS	11		184											0	73	25	2
	Becoming wet below a depth of 2.3 m.		4	SS	11																
183.0	ORGANIC SILT with wood fragments and roots Firm to very stiff Dark brown to black Wet		5	SS	5		183											0	30	63	7
3.0			6A	SS	20		182														
181.7	SAND and GRAVEL, trace to some silt, trace clay Compact to dense Brown Wet		7	SS	39		181														
4.3			8	SS	34													33	55	10	2
	Cobble inferred at a depth of 6.0 m.		9	SS	43		180														
			10	SS	19		179														
178.1	Granitic Gneiss (BEDROCK)		11	SS	50/0.10		178														
7.9	Bedrock cored from depths of 7.9 m to 9.4 m. For bedrock coring details refer to Record of Drillhole B502-06.		1	RC	REC 97%														RQD = 63%		
			2	RC	REC 100%		177												RQD = 100%		
176.6	END OF BOREHOLE																				
9.4	NOTE: 1. Water level in open borehole at a depth of 2.3 m below ground surface (Elev. 183.7 m) upon completion of drilling.																				

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B502-06

SHEET 1 OF 1

LOCATION: N 5082895.2 ;E 223094.2

DRILLING DATE: March 15 and 18, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Tripod

DRILLING CONTRACTOR: OGS DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
								RECOVERY			FRACT. INDEX PER 0.25	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
								TOTAL CORE %	SOLID CORE %	R.Q.D. %		B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn		10 ⁰			10 ¹	10 ²	10 ³																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
8	NORC March 17 and 18, 2014	Continued from Record of Borehole B502-06		178.14																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

DEPTH SCALE

1 : 50



LOGGED: TM

CHECKED: AB

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-07		SHEET 1 OF 1		METRIC														
W.P. 5145-08-01		LOCATION N 5082895.3 ; E 223099.6		ORIGINATED BY ID																
DIST HWY 69		BOREHOLE TYPE BW Casing, Wash Boring, Thin Wall NQ Coring		COMPILED BY MCK																
DATUM Geodetic		DATE February 25 to 27, 2014		CHECKED BY AB																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR	SA	SI	CL
							20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100						
186.4	GROUND SURFACE																			
0.0	TOPSOIL																			
0.2	SILTY SAND to SILT and SAND, trace clay Very loose to compact Brown Moist		1	SS	7		186													
			2	SS	4		185													
			3	SS	8		184													
183.9	ORGANIC SILT and SAND with wood fragments and roots Stiff to compact Brown and grey Moist		4	SS	9		183													
183.1			5	SS	12*		182													
3.3	SAND to SAND and GRAVEL Compact to very dense Grey to brown Wet Cobbles inferred at 3.3 m to 3.9 m and 4.7 m depths		6	RC	-		181													
			7	SS	11*		180													
			8	SS	30/0*		179													
			9	SS	43		178													
180.1	Granite Gneiss (BEDROCK)		10	SS	26/0.15		177													
6.3	Bedrock cored from depths of 6.3 m to 9.8 m For bedrock coring details Refer to Record of Drillhole B502-07.		1	RC	REC 100%															RQD = 30%
			2	RC	REC 82%															RQD = 77%
			3	RC	REC 100%															RQD = 100%
			4	RC	REC 100%															RQD = 100%
176.6	END OF BOREHOLE																			
9.8	NOTE: 1. Water level in piezometer at a depth of 3.7 m below ground surface (Elev. 182.7 m) on March 19, 2014. * Split-Spoon Sampler bouncing.																			

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B502-07

SHEET 1 OF 1

LOCATION: N 5082895.3 ;E 223099.6

DRILLING DATE: February 25 to 27, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Portable Tripod

DRILLING CONTRACTOR: OGS DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
								RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
								TOTAL CORE %	SOLID CORE %			B Angle		DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
								80 90 100	80 90 100			0 90 180	0 90 180			1 0 1 0 1 0	1 0 1 0 1 0				1 0 1 0																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
7	NORC February 25 to 27, 2014	Continued from Record of Borehole B502-07 Moderately to slightly weathered, foliated, dark grey/green to red, medium grained, medium strong to very strong GRANITIC GNEISS		180.07 6.33	1																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE		No B502-08		SHEET 1 OF 1		METRIC							
W.P. 09-1111-6014		LOCATION		N 5082899.0 ; E 223098.0		ORIGINATED BY		TM							
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring		COMPILED BY							
MCK		DATE		March 18, 2014		CHECKED BY		AB							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
186.3	GROUND SURFACE														
0.0	TOPSOIL														
	Silty SAND to SAND, some silt, trace clay Very loose to compact Brown to grey Moist to wet		1	SS	12*										
			2	SS	4										
			3	SS	9										
			4A	SS	6										
183.6	ORGANIC SILT, trace sand Brown and grey Wet		4B	SS	50/0.10										
183.1	SAND and GRAVEL, some silt Very dense Brown Wet		5	SS											
3.2	END OF BOREHOLE SPLIT-SPOON REFUSAL														
NOTE: 1. Water level in open borehole at a depth of 2.2 m below ground surface (Elev. 184.1 m) upon completion of drilling. * 'N' Value is impacted by frost.															

PROJECT		RECORD OF BOREHOLE		No B502-09		SHEET 1 OF 1		METRIC								
W.P. 09-1111-6014		LOCATION		N 5082941.3 ; E 223074.9		ORIGINATED BY		ID								
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring, NQ Coring		COMPILED BY								
DATUM		Geodetic		DATE		February 19 and 20, 2014		CHECKED BY								
								AB								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
178.6 0.0	ICE SURFACE ICE															
177.9 0.7	WATER															
176.8 1.8	SILT and SAND, trace organics Very loose to loose Dark grey Wet		1	SS	WR											
			2	SS	WR											
175.2 3.4	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 3.4 m to 6.6 m. For bedrock coring details refer to Record of Drillhole B502-09.		3	SS	7											
			1	RC	REC 100%											RQD = 88%
			2	RC	REC 98%											RQD = 87%
			3	RC	REC 97%											RQD = 97%
172.0 6.6	END OF BOREHOLE															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: LANDCORE DRILLING

[illegible]

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No B502-10		SHEET 1 OF 4		METRIC	
W.P. <u>5145-08-01</u>		LOCATION <u>N 5083001.3 ; E 223049.8</u>		ORIGINATED BY <u>MR</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring, NQ Coring</u>		COMPILED BY <u>MCK</u>			
DATUM <u>Geodetic</u>		DATE <u>February 13, 19 to 21, 2014</u>		CHECKED BY <u>AB</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		W _P	W	W _L	GR	SA	SI	CL
SHEAR STRENGTH kPa								WATER CONTENT (%)												
○ UNCONFINED + FIELD VANE																				
● QUICK TRIAXIAL × REMOULDED																				
178.5	WATER SURFACE							20	40	60	80	100	20	40	60					
0.0	ICE																			
178.0																				
0.5	WATER																			
							178													
							177													
							176													
							175													
174.6							174													
3.9	ORGANIC SILT, trace clay Very soft Dark grey Wet		1	SS	WR														126.9 ○	
			2	SS	WR															
			3	SS	WR														154.9 ○	
			4	SS	WR															
			5	SS	WR														178.3 ○	
170.5							171													
8.0	CLAYEY SILT Firm Grey Wet		6	SS	2		170						11	11	○					
			7	SS	3		169													
			8	SS	3		168													

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

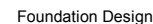
GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-10		SHEET 2 OF 4		METRIC																
W.P. 5145-08-01		LOCATION N 5083001.3 ; E 223049.8		ORIGINATED BY MR																		
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring		COMPILED BY MCK																		
DATUM Geodetic		DATE February 13, 19 to 21, 2014		CHECKED BY AB																		
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL			
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60 80 100	20 40 60	W _p W W _L	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60	
162.5	Silty SAND, trace clay Loose Grey Wet		11	SS	5		163															
16.0	CLAY, with silt seams to a depth of 17.1 m Fim to stiff Grey and brown Wet		12	SS	2		162															
							161															
			13	SS	3		160															
							159															
			14	SS	PH		158															
157.5	SILT, trace to some sand, trace to some clay Loose to compact Grey Wet		15	SS	7		157															
21.0							156															
			16	SS	6		155															
							154															
			17	SS	26		153															
							152															
			18	SS	15		151															
							150															
149.5	SAND, some silt, trace to some gravel Compact Grey Wet						149															
29.0																						

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\200909-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16



+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-10		SHEET 4 OF 4		METRIC									
W.P. 5145-08-01		LOCATION N 5083001.3 ; E 223049.8		ORIGINATED BY MR											
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring		COMPILED BY MCK											
DATUM Geodetic		DATE February 13, 19 to 21, 2014		CHECKED BY AB											
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	SHEAR STRENGTH kPa							
	--- CONTINUED FROM PREVIOUS PAGE ---														
132.9			24	SS	25/0.02	133									
45.6	COBBLES and BOULDERS		25	RC	REC 30%	132									
131.7															
46.8	Sandy GRAVEL Compact Grey Wet		26	SS	19	131									
						130									
						129									
128.3	Cobbles encountered at a depth of 49.8 m.		27	RC	REC 58%	128									
50.2	Granitic Gneiss (BEDROCK)		1	RC	REC 95%	127									
	Rock cored from depths of 50.2 m to 53.4 m		2	RC	REC 100%	126									
	For rock coring details refer to Record of Drillhole B502-10.		3	RC	REC 100%										
125.1	END OF BOREHOLE														
53.4	NOTE: * Split-Spoon Sampler bouncing.														

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: WALKER DRILLING

[illegible]

CHECKED: AB

GTARCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No B502-11		SHEET 1 OF 3	METRIC
W.P. <u>5145-08-01</u>	LOCATION <u>N 5083061.3 ; E 223024.7</u>	ORIGINATED BY <u>ID</u>			
DIST <u> </u> HWY <u>69</u>	BOREHOLE TYPE <u>NW Casing, Wash Boring, NQ Coring</u>	COMPILED BY <u>MCK</u>			
DATUM <u>Geodetic</u>	DATE <u>February 13 to 14 and 18 to 19, 2014</u>	CHECKED BY <u>AB</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)		
178.5 0.0	ICE SURFACE ICE													GR SA SI CL			
177.9 0.6	WATER																
176.7 1.8	Clayey ORGANIC SILT Very soft Dark grey Wet		1	SS	WR								151.3		OC = 6.4%	0 26 66 8	
			2	SS	WR												
			3	SS	WR										149.2		OC = 6.4%
			4	SS	WR												
			5	SS	WR												
			6	SS	WR										189.5		
172.3 6.2	CLAYEY SILT Soft to firm Grey Wet		7A	SS	1								113.6				
			7B														
			8	TO	PH												
			9	SS	2												
167.8 10.7	Sandy SILT, trace to some clay Loose Grey Wet		10	SS	5												
166.3 12.2	SILTY CLAY, with silt lenses Firm Brown to grey Wet		11	SS	1												
					12	TO	PH										
										</							

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-11		SHEET 3 OF 3		METRIC											
W.P. 5145-08-01		LOCATION N 5083061.3 ; E 223024.7		ORIGINATED BY ID													
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring		COMPILED BY MCK													
DATUM Geodetic		DATE February 13 to 14 and 18 to 19, 2014		CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m³	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	20 40 60	20 40 60	20 40 60	20 40 60	20 40 60				
148.0 30.5	Silty SAND, some gravel, trace clay Compact Grey Wet Cobble encountered at a depth of 31.7 m		20	SS	17		148										6 66 27 1
							147										
							146										
							145										
							144										
							143										
							142										
141.7 36.8	Pocket of Sandy SILT, some gravel at a depth of 36.7 m Granitic Gneiss (BEDROCK) Rock cored from depths of 36.8 m to 40.3 m For rock coring details refer to Record of Drillhole B502-11.		22	SS	15/0.010		142										15 23 58 4
			1	RC	REC 94%		141										RQD = 67%
			2	RC	REC 93%		140										RQD = 77%
			3	RC	REC 100%		139										RQD = 96%
138.2 40.3	END OF BOREHOLE																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B502-11

SHEET 1 OF 1

LOCATION: N 5083061.3 ;E 223024.7

DRILLING DATE: February 18 and 19, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: LANDCORE DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - Joint FLT - Fault SH - Shear VN - Vein CJ - Conjugate BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular PO - Polished K - Slickensided SM - Smooth RO - Rough VR - Very Rough MB - Mechanical Break BR - Broken Rock NOTE: For additional abbreviations refer to list of abbreviations & symbols.										NOTES							
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja		Jn	HYDRAULIC CONDUCTIVITY K, cm/sec			Diametral Point Load Index (MPa)	RMC -Q AVG	
								TOTAL CORE %	SOLID CORE %										10	10	10			
								8000000	8000000										8000000	8000000	8000000			
37	NORC February 18 and 19, 2014	Continued from Record of Borehole B502-11		141.66																				
		Slightly weathered, foliated, grey with pink bands, medium grained, faintly porous, weak to very strong, GRANITIC GNEISS		36.83	1										FO,PL,RO	1.5	1							7.7 MPa (Axial)
															FO,PL,RO	1.5	1							10.1 MPa
															JN,PL,RO	1.5	1							8.1 MPa (Axial)
															JN,UN,RO,Fe/Cl PC	3	3	6						
															JN,PL,RO	1.5	1							
															JN,PL,RO	1.5	1							
															JN,UN,RO	3	1							
															BC									
															LC									
38				2										JN,ST,RO	3	1	3							
														VN,UN,RO,Ca CC	3	3								
														JN,UN,SM,Mn SO	2	1								
														JN,UN,RO	3	1								
														JN,UN,RO,Fe SO	3	1								3.4 MPa (Axial)
39														FO,UN,RO	3	1								UCS = 22.7 MPa
40				3										JN,UN,RO,Ch SO	3	1		6						
														JN,UN,RO,Br/Cl IN	1	5		4						
														JN,PL,RO,Cl CC	1	5		1						1.7 MPa (Axial)
														JN,UN,RO	1	5		1						0.3 MPa
														JN,UN,VR,Fe SO	3	1								
	END OF DRILLHOLE			138.16																				
				40.33																				
41																								
42																								
43																								
44																								
45																								
46																								

DEPTH SCALE

1 : 50



LOGGED: ID

CHECKED: AB


GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT		09-1111-6014		RECORD OF BOREHOLE No B502-12		SHEET 1 OF 2		METRIC														
W.P.		5145-08-01		LOCATION		N 5083121.2; E 222999.6		ORIGINATED BY														
DIST		HWY 69		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY														
DATUM		Geodetic		DATE		March 4 and 5, 2014		CHECKED BY														
								AB														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR	SA	SI	CL	
								20	40	60	80	100	20	40	60							
179.3	0.0	GROUND SURFACE		1A	SS	1		179														
178.9	0.4	PEAT Very loose Dark brown Moist		1B	SS																	
178.1	1.2	Silty SAND, trace organics Loose Grey Wet		2A	SS	9																
		CLAYEY SILT to SILTY CLAY, trace to some sand Soft to firm Grey Wet		2B	SS																	
				3	SS	2																
				4	SS	1																
				5	TO	PH																
				6	SS	2																
				7	SS	1																
				8	SS	1																
				9	SS	3																
				10	SS	1																
				11	SS	8																
				1	RC	REC 100%																

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-12				SHEET 2 OF 2		METRIC									
W.P. 5145-08-01		LOCATION N 5083121.2; E 222999.6				ORIGINATED BY MR											
DIST HWY 69		BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring				COMPILED BY MCK											
DATUM Geodetic		DATE March 4 and 5, 2014				CHECKED BY AB											
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---																
	Granitic Gneiss (BEDROCK)		1	RC	REC 100%		164										RQD = 100%
	Bedrock cored from depths of 14.7 m to 18.0 m.		2	RC	REC 100%		163										RQD = 100%
	For bedrock coring details refer to Record of Drillhole B502-12.		3	RC	REC 100%		162										RQD = 93%
161.3 18.0	END OF BOREHOLE																
	NOTE: 1. Water level in open borehole at a depth of 0.5 m below ground surface (Elev. 178.8 m) upon completion of drilling.																


GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE		No B502-13		SHEET 1 OF 2		METRIC					
W.P.		LOCATION		ORIGINATED BY									
DIST		BOREHOLE TYPE		COMPILED BY									
DATUM		DATE		CHECKED BY									
09-1111-6014		N 5083167.3 ; E 222980.3		MR									
5145-08-01		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		MCK									
Geodetic		March 8, 2014		AB									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	GR SA SI CL
183.5	GROUND SURFACE		1	AS	-								
0.0	TOPSOIL		2A	SS	12		183						
183.0	SILT, some clay, trace sand Compact Brown Moist		2B	SS	12								
0.5	SAND, trace silt, trace organics to a depth of 1.0 m Very loose to compact Brown to grey Wet		3	SS	8		182						
			4	SS	4								
			5	SS	2		181						0 96 4 0
			6	SS	5								
			7	SS	6		180						
			8	SS	8		179						
178.0	CLAYEY SILT to SILTY CLAY, trace sand Firm Grey Wet		9	SS	4		178						
5.5			10	TO	PH		177						
			11	SS	1		176					17.6	
173.0	SILT, trace to some sand, trace to some clay, trace gravel Loose to compact Grey Wet		12	SS	4		175						
10.5			13	SS	10		174						
			14	SS	7		173						
169.0	BOULDER		15	RC REC	100%		172						
168.7							171						4 8 81 7
							170						
							169						

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE				No B502-13		SHEET 2 OF 2		METRIC							
W.P. 5145-08-01		LOCATION				N 5083167.3 ; E 222980.3		ORIGINATED BY MR									
DIST		HWY 69		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY MCK									
DATUM Geodetic		DATE		March 8, 2014				CHECKED BY AB									
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100						
15.0	Granitic Gneiss (BEDROCK)		1	RC	REC 100%												RQD = 100%
	Bedrock cored from depths of 15.0 m to 18.0 m.																
	For bedrock coring details refer to Record of Drillhole B502-13.																
			2	RC	REC 100%												RQD = 87%
165.5	END OF BOREHOLE																
18.0	NOTES:																
	1. Water level in piezometer at a depth of 1.4 m below ground surface (Elev. 182.1 m) on March 19, 2014.																
	2. Piezometer was installed 0.5 m West of Borehole B502-13.																

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: WALKER DRILLING

CHECKED: AB

GTARCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-14		SHEET 1 OF 2		METRIC														
W.P. 5145-08-01		LOCATION N 5083185.8 ; E 222972.5		ORIGINATED BY MAS																
DIST _____ HWY 69		BOREHOLE TYPE 150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY MCK																
DATUM Geodetic		DATE March 10, 2014		CHECKED BY AB																
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%) W _p — W — W _L			γ	GR	SA	SI	CL
186.2	GROUND SURFACE							20 40 60 80 100												
0.0	TOPSOIL		1A		7		186													
0.2	SILT and SAND, trace clay Loose to compact Brown Moist		1B	SS																
			2	SS	14		185													
			3	SS	16		184													
			4	SS	13		183													
			5	SS	8		182													
181.6	CLAYEY SILT Stiff Grey Wet		6	SS	3		181													
							180													
180.1	SILT and SAND, trace clay Loose Grey Wet		7	SS	6		179													
			8	SS	6		178													
178.0	CLAYEY SILT to SILTY CLAY Firm Grey Wet		9	SS	4		177													
			10	TO	PH		176													
			11	SS	WH		175													
172.5	SILT, some sand Compact Grey Wet		12	SS	13		174													
13.7							173													
171.4							172													
14.8																				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No B502-14				SHEET 2 OF 2		METRIC	
W.P. <u>5145-08-01</u>		LOCATION <u>N 5083185.8 ;E 222972.5</u>				ORIGINATED BY <u>MAS</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring</u>				COMPILED BY <u>MCK</u>			
DATUM <u>Geodetic</u>		DATE <u>March 10, 2014</u>				CHECKED BY <u>AB</u>			

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			W _L
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100						
	END OF BOREHOLE SPLIT-SPOON REFUSAL NOTE: 1. Water level in open borehole at a depth of 4.3 m below ground surface (Elev. 181.9 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-15				SHEET 1 OF 1		METRIC								
W.P. 5145-08-01		LOCATION N 5082935.7 ; E 223069.1				ORIGINATED BY MR										
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring				COMPILED BY MCK										
DATUM Geodetic		DATE February 23, 2014				CHECKED BY AB										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
178.6 0.0	ICE SURFACE ICE															
178.1 0.5	WATER															
177.4 1.2	SAND, some silt, trace organics Very loose Dark brown Wet		1	SS	WR											
176.2 2.4	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 2.4 m to 5.6 m. For bedrock coring details refer to Record of Drillhole B502-15.		2	SS	1											
176.2 2.4	Granitic Gneiss (BEDROCK) Bedrock cored from depths of 2.4 m to 5.6 m. For bedrock coring details refer to Record of Drillhole B502-15.		1	RC	REC 100%											RQD = 94%
175.0 5.2																
174.0 6.2			2	RC	REC 100%											RQD = 88%
173.0 5.6	END OF BOREHOLE															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B502-15

SHEET 1 OF 1

LOCATION: N 5082935.7 ;E 223069.1

DRILLING DATE: February 25, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT INDEX PER 0.25	B Angle	DIP w.r.t CORE AXIS	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES
									TOTAL CORE %	SOLID CORE %					TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 10 10 10	10 10 10 10					
3 																									

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT		RECORD OF BOREHOLE		No B502-16		SHEET 1 OF 1		METRIC							
W.P. 5145-08-01		LOCATION		N 5082941.2 ; E 223066.8		ORIGINATED BY		MR							
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring		COMPILED BY							
DATUM		Geodetic		DATE		February 23, 2014		CHECKED BY							
								AB							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
178.6	ICE SURFACE														
0.0	ICE														
178.0							178								
0.6	WATER						177								
							176								
175.6							175								
3.0	Silty SAND, some clay, trace organics Very loose Dark grey Wet		1	SS	WR										
			2	SS	WR										
							174								
173.1			3	SS	WH										
5.5	ORGANIC SILT, trace to some clay Very soft Dark grey Wet		4	SS	WH		173								
171.7			5	SS	WH		172								
6.9	END OF BOREHOLE CASING REFUSAL														

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA-GDT 10/13/16

PROJECT		RECORD OF BOREHOLE				No B502-17		SHEET 1 OF 1		METRIC				
W.P. 09-1111-6014		LOCATION		N 5082941.5 ; E 223083.0		ORIGINATED BY		MR						
DIST		HWY 69		BOREHOLE TYPE		NW Casing, Wash Boring		COMPILED BY		MCK				
DATUM		Geodetic		DATE		February 25, 2014		CHECKED BY		AB				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
178.6	ICE SURFACE													
0.0	ICE													
178.0														
0.6	WATER													
177.1														
1.5	ORGANIC SILT													
176.6	Very soft		1	SS	WR									
2.0	Grey													
	Wet													
	END OF BOREHOLE CASING REFUSAL													

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No B502-18		SHEET 1 OF 1		METRIC											
W.P. 5145-08-01		LOCATION N 5082947.0 ; E 223080.6		ORIGINATED BY MR													
DIST HWY 69		BOREHOLE TYPE NW Casing, Wash Boring, NQ Coring		COMPILED BY MCK													
DATUM Geodetic		DATE February 22, 2014		CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	20 40 60	20 40 60	20 40 60 80 100			
178.6	WATER SURFACE																
0.0	ICE																
178.1																	
0.5	WATER																
175.5																	
3.1	ORGANIC SILT, trace to some sand, trace to some clay Very soft Dark grey Wet		1	SS	WR												
			2	SS	WR												
			3	SS	WH												
			4	SS	WR												
			5	SS	WR												
171.5																	
7.1	Granitic Gneiss (BEDROCK) Rock cored from depths of 7.1 m to 10.7 m For rock coring details refer to Record of Drillhole B502-18.		1	RC	REC 100%												RQD = 91%
			2	RC	REC 100%												RQD = 100%
			3	RC	REC 100%												RQD = 100%
167.9																	
10.7	END OF BOREHOLE																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 10/13/16

PROJECT: 09-1111-6014

RECORD OF DRILLHOLE: B502-18

SHEET 1 OF 1

LOCATION: N 5082947.0 ;E 223080.6

DRILLING DATE: February 22 to 23, 2014

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: Diedrich D25

DRILLING CONTRACTOR: WALKER DRILLING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX PER 0.25	DISCONTINUITY DATA					HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q AVG	NOTES			
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10	10	10				10		
		Continued from Record of Borehole B502-18		171.50																						
8	NW Casing	Slightly weathered to fresh, foliated, grey, medium grained, strong GRANITIC GNEISS		7.10	1																				8.3 MPa (Axial) 11.0 MPa	
9	NQRC February 22 to 23, 2014				2																					6.2 MPa 5.0 MPa (Axial)
10					3																					8.3 MPa 7.6 MPa (Axial)
11		END OF DRILLHOLE		167.93 10.67																						
12																										
13																										
14																										
15																										
16																										
17																										

DEPTH SCALE

1 : 50



LOGGED: MR

CHECKED: AB

GTA-RCK 018 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-MISS.GDT 10/13/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S502-08		SHEET 1 OF 2		METRIC	
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083197.7 ; E 222942.6</u>		ORIGINATED BY <u>SA</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>106 mm I.D. Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>GRL</u>			
DATUM <u>Geodetic</u>		DATE <u>March 6 and 7, 2013</u>		CHECKED BY <u>CN</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED + FIELD VANE						
190.6	GROUND SURFACE						20 40 60 80 100							
0.0	PEAT (Fibrous)		1A	SS	2									
0.2	Very soft Dark brown Wet		1B	SS										
189.7	CLAYEY SILT		2A											
0.9	Very soft Brown Wet		2B	SS	17									
	SAND, trace to some silt, trace clay Loose to compact Brown to becoming grey below a depth of 3.8 m Moist to Wet		3	SS	15									
			4	SS	7									
			5	SS	6									
			6	SS	17									
			7	SS	20									
185.0	Sandy SILT, trace clay Loose Grey Wet		8	SS	7									
183.4	CLAYEY SILT		9	SS	2									
7.2	Firm Grey Wet		10	SS	WH									
180.5	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		11	SS	3									
10.1			12	SS	5									
177.3	CLAYEY SILT, containing silt seams Soft Grey Wet		13	SS	3									
13.3														
175.8														
14.8														

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-08		SHEET 2 OF 2		METRIC							
W.P. 09-1111-6014		LOCATION		N 5083197.7 ; E 222942.6		ORIGINATED BY		SA							
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY							
GRL		DATE		March 6 and 7, 2013		CHECKED BY		CN							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100							
172.7	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		14	SS	9		175								0 10 87 3
							174								
			15	SS	WR		173								
17.9	SILT and SAND, trace clay Very loose Grey Wet		16	SS	3		172								0 39 57 4
170.9	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL		17	SS			171								
19.7	NOTE: 1. Water level in open borehole at a depth of 6.7 m below ground surface (Elev. 183.9 m) upon completion of drilling.														

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		09-1111-6014		RECORD OF BOREHOLE No S502-12		SHEET 1 OF 1		METRIC								
W.P.		5005-10-01		LOCATION		N 5083243.4 ; E 222922.1		ORIGINATED BY SA								
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY GRL								
DATUM		Geodetic		DATE		March 7, 2013		CHECKED BY CN								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
192.1	GROUND SURFACE							20	40	60	80	100				
0.0	TOPSOIL		1A	SS	3		192									
0.2	CLAYEY SILT Soft to firm Grey Wet		1B	SS	3											
191.0			2A	SS	6		191									
1.1	SAND, trace to some silt, trace to some clay, trace gravel Loose to compact Brown and grey Wet		2B	SS	6											
			3	SS	9											
			4	SS	10		190									
			5	SS	12		189									
			6A	SS	5		188									
187.8	CLAYEY SILT Brown Wet		6B	SS	5											
187.5	SILT and SAND, trace clay Very loose to compact Grey Wet		7	SS	18		187									
4.6			8	SS	10		186									
			9	SS	3		185									
			10	SS	5		184									
			11	SS	3		183									
			12	SS	25/0.18		182									
179.6	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL						181									
12.5	NOTE: 1. Water level in open borehole at a depth of 7.6 m below ground surface (Elev. 184.5 m) upon completion of drilling.						180									

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		09-1111-6014		RECORD OF BOREHOLE No S502-18		SHEET 1 OF 2		METRIC														
W.P.		5005-10-01		LOCATION		N 5083149.0 ; E 222988.0		ORIGINATED BY ID														
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY AV														
DATUM		Geodetic		DATE		March 13 and 14, 2013		CHECKED BY CN														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV	DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR	SA	SI	CL	
								20	40	60	80	100	20	40	60							
181.3	0.0	GROUND SURFACE		1A	SS	1	▽	181														
181.0	0.3	PEAT (Fibrous) Very soft Black Wet		1B	SS	1																
180.5	0.8	CLAYEY SILT, trace to some sand, trace gravel, trace organics Very soft Dark grey Wet		2	SS	7		180														
179.8	1.5	SAND, trace to some gravel Loose Brown Wet		3	SS	1																
179.1	2.2	CLAYEY SILT, with silt seams Very soft Grey Wet		4	SS	4		179														
		SILT and SAND, trace clay Very loose Grey Wet		5	SS	3		178														
177.6	3.7	SILTY CLAY, with silt seams Firm Grey Wet		6	SS	7		177														
				7	SS	WH		176														
175.5	5.8	CLAYEY SILT Firm to stiff Grey Wet		8	SS	1		175														
				9	TO	PH		174														
				10	SS	3		173														
				11A	SS	1		172														
170.2	11.1	SILT, trace to some sand, trace to some clay Very loose to compact Grey Wet		11B	SS	1		171														
				12	SS	8		170														
				13	SS	16		169														
								168														
								167														
166.6	14.7	END OF BOREHOLE																				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S502-18				SHEET 2 OF 2		METRIC																
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083149.0 ; E 222988.0</u>				ORIGINATED BY <u>ID</u>																		
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>106 mm I.D. Continuous Flight Hollow Stem Augers</u>				COMPILED BY <u>AV</u>																		
DATUM <u>Geodetic</u>		DATE <u>March 13 and 14, 2013</u>				CHECKED BY <u>CN</u>																		
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			W _L							
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>																	
	AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 181.0 m) upon completion of drilling.																							

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-19		SHEET 1 OF 1		METRIC								
W.P. 09-1111-6014		LOCATION		N 5083170.6; E 223007.3		ORIGINATED BY		MA								
DIST. HWY 69		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY		AV								
DATUM Geodetic		DATE		March 11, 2013		CHECKED BY		CN								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
180.9	GROUND SURFACE															
0.0	PEAT (Fibrous)		1A	SS	2											
0.4	Very soft Dark brown Wet		1B													
179.7	ORGANIC SILT, trace sand		2A	SS	2											
1.2	Very soft Grey Wet		2B													
178.9	CLAYEY SILT, containing sand seams and silt lenses		3A	SS	4											
	Soft to firm Grey Wet		3B													
2.2	SILT and SAND		4	SS	2											
	Grey Wet															
	CLAYEY SILT, containing silty sand seams		5	SS	1											
	Firm to stiff Grey Wet															
			6	SS	1											
			7	SS	1											
			8	TO	PH											
172.0	SILT		9	SS	3											
8.9	Very loose Grey Wet															
171.1	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL		10	SS												
9.8																
NOTE: 1. Water level in open borehole at a depth of 2.0 m below ground surface (Elev. 178.9 m) upon completion of drilling.																

PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-20		SHEET 1 OF 2		METRIC															
W.P. 5005-10-01		LOCATION N 5083172.0 ; E 222978.4		ORIGINATED BY ID																	
DIST HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY GRL																	
DATUM Geodetic		DATE March 1 and 4, 2013		CHECKED BY CN																	
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
184.1	GROUND SURFACE							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L 20 40 60			kN/m ³					
0.0	TOPSOIL		1A	SS	6		184														
183.8	Black		1B	SS	6																
0.3	SAND, trace silt, trace organics Very loose to loose Brown becoming grey below a depth of 2.3 m Moist to wet		2	SS	7		183														
			3	SS	6		182														
			4	SS	WH		181														
			5	SS	WH		180														
180.4			6	SS	6		179														
3.7	SILT and SAND, trace clay Loose Grey Wet		7	SS	5		178														
	Clayey silt seams below a depth of 4.6 m		8	SS	WH		177														
			9	SS	1		176														
178.0			10	TO	PH		175														
6.1	CLAY Soft to stiff Grey Wet		11A	SS	WH		174														
			11B	SS	WH		173														
173.6	CLAYEY SILT Very soft Grey Wet		12	SS	3		172														
10.5			13	SS	10/0.05		171														
173.0	SILT, some sand, trace to some clay Very loose Grey Wet																				
11.1																					
172.4	SILT and SAND, trace clay Very loose Grey Wet																				
11.7																					
170.6																					
13.5																					

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-20				SHEET 2 OF 2		METRIC								
W.P. 5005-10-01		LOCATION N 5083172.0 ; E 222978.4				ORIGINATED BY ID										
DIST HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY GRL										
DATUM Geodetic		DATE March 1 and 4, 2013				CHECKED BY CN										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 2.1 m below ground surface (Elev. 182.0 m) upon completion of drilling.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		09-1111-6014		RECORD OF BOREHOLE No S502-20A		SHEET 1 OF 2		METRIC						
W.P.		5005-10-01		LOCATION		N 5083189.5 ; E 222993.4		ORIGINATED BY						
DIST		HWY 69		BOREHOLE TYPE		150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring		COMPILED BY						
DATUM		Geodetic		DATE		March 9, 2014		CHECKED BY						
								JPD						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
184.2	GROUND SURFACE													
0.0	TOPSOIL Dark brown Moist		1A	SS	12 *									
183.6	SAND, some gravel, trace silt Loose to compact Brown Moist		1B	SS	4									
0.6			2	SS	4									
182.7	SILT, trace sand, trace clay Loose Brown to grey Wet		3A											
1.5			3B	SS	5									
181.6	CLAYEY SILT, trace sand Soft to firm Grey Wet		4	SS	4									0 3 69 28
2.6	SAND Very loose to loose Grey Wet		5	SS	2									
			6	SS	7									
			7	SS	6									
179.0														
5.2	SILT CLAY to CLAY, trace sand Soft to firm Grey Wet		8	SS	2									
177.1	SILT, trace to some sand, trace clay Loose Grey Wet		9	TO	PH									
			10	SS	9									0 6 90 4
			11	SS	10									
172.9														
11.3	SAND, some gravel Very dense Grey Wet		12	SS	50/0.15									
171.8														
12.4														

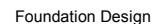
Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA-GDT 07/25/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S502-20A				SHEET 2 OF 2		METRIC								
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083189.5 ;E 222993.4</u>				ORIGINATED BY <u>MR</u>										
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>150 mm O.D. Continuous Flight Solid Stem Augers, NW Casing, Wash Boring</u>				COMPILED BY <u>BM</u>										
DATUM <u>Geodetic</u>		DATE <u>March 9, 2014</u>				CHECKED BY <u>JPD</u>										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> 20 40 60 </div>			kN/m ³	GR SA SI CL
	END OF BOREHOLE NOTES: 1. Water level in open borehole at a depth of 0.6 m below ground surface (Elev. 183.6 m) upon completion of drilling. 2. An (S502-20B) additional borehole was advanced 0.5 m east of borehole S502-20A to obtain a Shelby Tube sample at a depth of 5.5 m (Elev. 178.7 m) and to carry out in situ field vanes at depths of 6.4 m (Elev. 177.8 m) and 6.7 m (Elev. 177.5 m). * "N" Value impacted by frozen ground.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16



+3, ×3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-21		SHEET 1 OF 2		METRIC														
W.P. 5005-10-01		LOCATION N 5083176.3 ; E 222956.2		ORIGINATED BY ID																
DIST HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY GRL																
DATUM Geodetic		DATE February 27, 2013		CHECKED BY CN																
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m ³	GR SA SI CL			
							20 40 60 80 100	○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p — W — W _L							
187.3	GROUND SURFACE																			
0.0	TOPSOIL		1A		4		187													
0.2	Silty SAND, trace clay Loose Brown Moist		1B	SS																
			2	SS	6															
							186													
			3	SS	8															
185.1																				
2.2	SILT and SAND, trace to some clay Very loose to compact Brown Moist to wet		4	SS	11		185													
			5	SS	5		184													
			6	SS	3		183													
	Containing clayey silt seams below a depth of 4.6 m.		7	SS	3		182													
181.7																				
5.6	CLAYEY SILT, trace to some sand Very soft Grey Moist		8A				181													
180.9			8B	SS	1															
6.4	SILT and SAND, trace clay Very loose Grey Wet						180													
			9	SS	1		179													
178.6																				
8.7	SILTY CLAY Firm Grey Wet		10	SS	WH		178													
							177													
			11	SS	WH		176													
175.1																				
12.2	SILT, some sand, trace clay Very loose to loose Grey Wet		12	SS	WH		175													
							174													
			13	SS	9		173													

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA-GDT 07/25/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-21				SHEET 2 OF 2		METRIC								
W.P. 5005-10-01		LOCATION N 5083176.3 ; E 222956.2				ORIGINATED BY ID										
DIST _____ HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers				COMPILED BY GRL										
DATUM Geodetic		DATE February 27, 2013				CHECKED BY CN										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100					WATER CONTENT (%) 20 40 60				
170.8	SILT, some sand, trace clay Very loose to loose Grey Wet		14	SS	4		172									
16.5	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 4.0 m below ground surface (Elev. 183.3 m) upon completion of drilling.		15	SS	-		171									

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S502-22		SHEET 1 OF 2		METRIC	
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083195.1 ; E 222968.7</u>		ORIGINATED BY <u>SA</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>106 mm I.D. Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>CC/AV</u>			
DATUM <u>Geodetic</u>		DATE <u>March 4 and 5, 2013</u>		CHECKED BY <u>CN</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								UNCONFINED ○	FIELD VANE +					
188.0	GROUND SURFACE													
0.0	TOPSOIL		1A	SS	5									
0.1	SILTY CLAY, trace organics Firm Brown and grey Wet		1B	SS										
187.1			2A											
0.9	Silty SAND, trace clay Very loose to compact Brown Moist		2B	SS	7									
			3	SS	9									
			4	SS	11									
185.0														
3.0	SILT and SAND, trace clay Very loose to compact Grey Moist to wet		5	SS	10									0 75 23 2
			6	SS	2									0 51 47 2
			7	SS	4									
			8	SS	2									
			9	SS	5									
178.6			10A											
9.4	CLAYEY SILT, trace sand Firm Grey Wet		10B	SS	4									
177.5														
10.5	SILT, some sand Very loose Grey Wet		11A	SS	2									
177.0			11B											
11.0	SILTY CLAY, trace sand Firm to stiff Grey Wet													
			12	TO	PH									
174.7														
13.3	SILT, trace to some sand, trace clay Loose Grey Wet		13	SS	7									0 10 86 4
173.3														
14.7														

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-22		SHEET 2 OF 2		METRIC								
W.P. 09-1111-6014		LOCATION		N 5083195.1 ; E 222968.7		ORIGINATED BY		SA								
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY								
DATUM		Geodetic		DATE		March 4 and 5, 2013		CHECKED BY								
								CN								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
	SILT and SAND, trace clay Very loose Grey Wet		14	SS	WR											
			15	SS	WR											
170.2																
17.8	SILT, trace to some sand, trace clay Very loose to loose Grey Wet															
169.3			16	SS	4											
18.7	END OF BOREHOLE SPLIT-SPOON REFUSAL NOTE: 1. Water level in open borehole at a depth of 4.6 m below ground surface (Elev. 183.4 m) upon completion of drilling.															

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT <u>09-1111-6014</u>		RECORD OF BOREHOLE No S502-23		SHEET 1 OF 2		METRIC	
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083212.8 ; E 222978.6</u>		ORIGINATED BY <u>SA</u>			
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>106 mm I.D. Continuous Flight Hollow Stem Augers</u>		COMPILED BY <u>GRL</u>			
DATUM <u>Geodetic</u>		DATE <u>March 5 and 6, 2013</u>		CHECKED BY <u>CN</u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)							
								20	40	60	80	100	W _p	W	W _L		GR	SA	SI	CL
188.7	GROUND SURFACE																			
0.0	TOPSOIL		1A																	
0.2	CLAYEY SILT, trace sand, trace organics Soft to firm Brown Moist		1B	SS	3															
			2	SS	7															
187.3																				
1.4	SILT and SAND, trace to some clay Loose to compact Brown, becoming grey below a depth of 3.8m Wet		3	SS	11												0	58 36 6		
			4	SS	14															
			5	SS	14															
			6	SS	6												0	57 41 2		
184.2																				
4.5	SAND, some silt Very loose Grey Wet		7	SS	3												0	82 18 0		
182.6																				
6.1	SILT, trace to some clay, containing silty clay seams Very loose Grey Wet		8	SS	1															
181.4																				
7.3	SILT and SAND, trace clay Loose to compact Grey wet		9	SS	7															
			10	SS	8												0	58 41 1		
177.6			11A	SS	19															
11.1	SILTY CLAY Firm to stiff Grey Wet		11B																	
176.5																				
12.2	SILT, trace to some sand, trace clay Very loose to loose Grey Wet		12	SS	1													Non-Plastic		
			13	SS	7															
173.7																				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\200909-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-23		SHEET 2 OF 2		METRIC								
W.P. 5005-10-01		LOCATION		N 5083212.8 ; E 222978.6		ORIGINATED BY		SA								
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY								
GRL		DATE		March 5 and 6, 2013		CHECKED BY		CN								
DATUM		Geodetic														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---															
15.0	SILT Very loose to loose Grey wet		14	SS	WH		173									
172.4																
16.3	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 4.9 m below ground surface (Elev. 183.8 m) upon completion of drilling.		15	SS	10/0.0											

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT 09-1111-6014		RECORD OF BOREHOLE No S502-24		SHEET 1 OF 2		METRIC											
W.P. 5005-10-01		LOCATION N 5083218.2 ; E 222959.0		ORIGINATED BY ID													
DIST HWY 69		BOREHOLE TYPE 106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY GRL													
DATUM Geodetic		DATE February 27 and 28, 2013		CHECKED BY CN													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	γ	GR	SA	SI	CL
190.3	GROUND SURFACE																
0.0	TOPSOIL Soft Dark brown to black Wet		1	SS	3		190						OC = 6.3%				
189.5							189										
0.8	SAND, trace to some silt, trace clay Loose to compact Brown Moist		2	SS	9												
			3	SS	13		188										
			4	SS	8												
			5	SS	10		187										
			6	SS	15		186										
			7	SS	17												
184.7							185										
5.6	SILT and SAND, trace clay Very loose to loose Grey Wet Clayey silt seams below a depth of 7.6 m		8	SS	5		184										
							183										
			9	SS	2		182										
181.6							181										
8.7	SAND, some silt Very loose to loose Grey Wet		10	SS	5		180										
							179										
			11	SS	3		178										
178.6							177										
11.7	CLAY, with silt seams Firm Grey Wet		12	SS	1		176										
176.8																	
13.5	SILT, trace clay Very loose Grey Wet		13	SS	1												

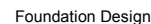
Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

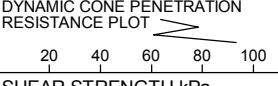
GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT		RECORD OF BOREHOLE		No S502-24		SHEET 2 OF 2		METRIC									
W.P. 09-1111-6014		LOCATION		N 5083218.2; E 222959.0		ORIGINATED BY		ID									
DIST		HWY 69		BOREHOLE TYPE		106 mm I.D. Continuous Flight Hollow Stem Augers		COMPILED BY									
GRL		DATE		February 27 and 28, 2013		CHECKED BY		CN									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
174.0	SILT, trace clay Very loose Grey Wet		14	SS	WH		175										
16.3	SILT and SAND, trace gravel, trace clay Loose Grey Wet		15	SS	8		174										
172.6			16	SS			173										5 45 47 3 Non-Plastic
17.7	END OF BOREHOLE SPLIT-SPOON AND AUGER REFUSAL NOTE: 1. Water level in open borehole at a depth of 6.0 m below ground surface (Elev. 184.3 m) upon completion of drilling.																

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16



+3, ×3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>09-1111-6014</u>		RECORD OF DCPT No S502-DC08		SHEET 1 OF 1		METRIC					
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083189.8 ; E 222994.3</u>		ORIGINATED BY <u>ID</u>							
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>		COMPILED BY <u>AV</u>							
DATUM <u>Geodetic</u>		DATE <u>February 27, 2013</u>		CHECKED BY <u>JPD</u>							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE							"N" VALUES
184.2 0.0	GROUND SURFACE Dynamic Cone Penetration Test (DCPT)										
						184					
						183					
						182					
						181					
						180					
						179					
						178					
						177					
						176					
						175					
						174					
						173					
						172					
171.3 13.0	END OF DCPT Refusal to Further Penetration (30 Blows / 0.0 m)										

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

PROJECT <u>09-1111-6014</u>				RECORD OF DCPT No S502-DC09				SHEET 1 OF 2		METRIC			
W.P. <u>5005-10-01</u>		LOCATION <u>N 5083199.0 ; E 222951.4</u>				ORIGINATED BY <u>EHS</u>							
DIST <u> </u> HWY <u>69</u>		BOREHOLE TYPE <u>Dynamic Cone Penetration Test</u>				COMPILED BY <u>AV</u>							
DATUM <u>Geodetic</u>		DATE <u>March 4, 2013</u>				CHECKED BY <u>JPD</u>							
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
190.0	GROUND SURFACE						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>						
0.0	Dynamic Cone Penetration Test (DCPT)												
189													
188													
187													
186													
185													
184													
183													
182													
181													
180													
179													
178													
177													
176													

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2009\09-1111-6014 (URS, HWY 69, HENVEY)\LOG\09-1111-6014.GPJ GAL-GTA.GDT 07/25/16

1 OF 5

G.W.P. 5377-02-00	LOCATION Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 223022 E	ORIGINATED BY JF
DIST 54 HWY 69	BOREHOLE TYPE Portable Drilling Equipment - Wash Boring	COMPILED BY SN
DATUM Geodetic	DATE 18 February 2006 - 21 February 2006	CHECKED BY IH
PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522		JOB NO. TT53126

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS ▽	DEPTH m	ELEVATION SCALE m	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa						WATER CONTENT (%)
									○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
178.5 0.0	about 500 mm ICE														
178.0 0.5	----- WATER						178								
							1								
							177								
							2								
							176								
175.5 3.1	SILTY CLAY / SILT AND CLAY / CLAYEY SILT trace sand, trace organics grey, very soft to hard, medium plasticity, wet CI		1	SS	0		3								
							175								
							4								
							174								
							5								
							173								
							6	+²							
							172								
							7								
							171								
			2	SS	4										

For SS2:
w_n=44%

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

2 OF 5

G.W.P. 5377-02-00 LOCATION Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 223022 E ORIGINATED BY JF
 DIST 54 HWY 69 BOREHOLE TYPE Portable Drilling Equipment - Wash Boring COMPILED BY SN
 DATUM Geodetic DATE 18 February 2006 - 21 February 2006 CHECKED BY IH
 PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522 JOB NO. TT53126

[illegible]

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

3 OF 5

G.W.P. 5377-02-00 LOCATION Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 223022 E ORIGINATED BY JF
 DIST 54 HWY 69 BOREHOLE TYPE Portable Drilling Equipment - Wash Boring COMPILED BY SN
 DATUM Geodetic DATE 18 February 2006 - 21 February 2006 CHECKED BY IH
 PROJECT Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522 JOB NO. TT53126

[illegible]

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

4 OF 5

G.W.P. <u>5377-02-00</u>	LOCATION <u>Center of Straight Lake, Mowat Township, Co-ords: 5083027 N; 223022 E</u>	ORIGINATED BY <u>JF</u>
DIST <u>54</u> HWY <u>69</u>	BOREHOLE TYPE <u>Portable Drilling Equipment - Wash Boring</u>	COMPILED BY <u>SN</u>
DATUM <u>Geodetic</u>	DATE <u>18 February 2006 - 21 February 2006</u>	CHECKED BY <u>IH</u>
PROJECT <u>Highway 69 Route Selection Study, from 3.5 km North of HWY 559 to 3.8 km North of HWY 522</u>		JOB NO. <u>TT53126</u>

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DEPTH m	ELEVATION SCALE M ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH (m)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES				SHEAR STRENGTH kPa						WATER CONTENT (%)			
153.9	SILTY CLAY / SILT AND CLAY / CLAYEY SILT trace sand and gravel grey, firm, high plasticity, wet CH						154											
24.6	SILT / SANDY SILT / SILT AND SAND with clay, trace sand grey, compact to very dense, low placticity, wet CL-ML						25											
							153											
			10	SS	45		26											
							152											
							27											
			11	SS	12		151											
							28											
							150											
							29											
							149											
							30											
							148											
			12	SS	51		31											
							147											

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE



APPENDIX B

Laboratory Test Results and Bedrock Core Photographs

TABLE B1
POINT LOAD TEST RESULTS ON ROCK SAMPLES

Foundation Element	Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core ⁽²⁾ Diameter (mm)	Is (50mm) (MPa)	Approx. UCS Value ⁽¹⁾ (MPa)
South Abutment	B502-05	1	5.0	180.7	Granitic Gneiss	Axial	42	45	10.9	153
	B502-05	1	5.0	180.7	Granitic Gneiss	Diametral	90	45	10.5	147
	B502-05	2	6.0	179.7	Granitic Gneiss	Axial	35	45	12.7	178
	B502-05	2	6.0	179.7	Granitic Gneiss	Diametral	71	45	8.9	125
	B502-05	3	6.3	179.4	Granitic Gneiss	Diametral	55	45	8.2	114
	B502-05	3	6.3	179.4	Granitic Gneiss	Axial	33	45	9.9	138
	B502-05	4	7.0	178.7	Granitic Gneiss	Diametral	68	45	9.8	138
	B502-05	4	7.0	178.7	Granitic Gneiss	Axial	35	45	11.0	154
	B502-05	4	7.4	178.3	Granitic Gneiss	Diametral	76	45	7.7	107
	B502-06	1	8.5	177.5	Granitic Gneiss	Diametral	60	45	5.7	80
	B502-06	2	8.8	177.2	Granitic Gneiss	Diametral	67	45	7.7	108
	B502-07	2	8.0	178.4	Granitic Gneiss	Axial	48	45	1.4	19
	B502-07	3	8.1	178.3	Granitic Gneiss	Diametral	140	45	2.9	41
	B502-07	4	9.4	177.0	Granitic Gneiss	Axial	45	45	9.2	128
	B502-07	4	9.5	176.9	Granitic Gneiss	Diametral	120	45	8.7	122
Between South Abutment and Pier 1	B502-09	1	3.7	174.9	Granitic Gneiss	Diametral	78	45	13.2	185
	B502-09	1	4.3	174.3	Granitic Gneiss	Diametral	112	45	7.5	105
	B502-09	1	4.3	174.3	Granitic Gneiss	Axial	56	45	6.4	89
	B502-09	2	5.5	173.1	Granitic Gneiss	Diametral	95	45	11.5	161
	B502-09	2	5.7	172.9	Granitic Gneiss	Axial	58	45	8.1	113
	B502-09	3	6.1	172.5	Granitic Gneiss	Diametral	71	45	10.5	147
	B502-09	3	6.1	172.5	Granitic Gneiss	Axial	30	45	8.4	117
	B502-15	1	3.7	174.9	Granitic Gneiss	Axial	45	45	10.3	144
	B502-15	1	3.8	174.8	Granitic Gneiss	Diametral	125	45	10.6	149
	B502-15	2	5.2	173.5	Granitic Gneiss	Axial	45	45	8.1	113
	B502-15	2	5.3	173.3	Granitic Gneiss	Diametral	100	45	9.2	129
	B502-18	1	7.7	170.9	Granitic Gneiss	Axial	49	45	8.3	116
	B502-18	1	7.9	170.7	Granitic Gneiss	Diametral	77	45	11.0	154
	B502-18	2	8.5	170.1	Granitic Gneiss	Diametral	56	45	6.2	87
	B502-18	2	8.6	170.0	Granitic Gneiss	Axial	34	45	5.0	70
	B502-18	3	9.4	169.2	Granitic Gneiss	Diametral	82	45	8.3	116
	B502-18	3	9.7	168.9	Granitic Gneiss	Axial	46	45	7.6	107
Pier 1	B502-01	1	12.9	165.7	Granitic Gneiss	Axial	47	47	8.0	112
	B502-01	1	12.9	165.7	Granitic Gneiss	Diametral	121	47	9.9	139
	B502-01	2	14.4	164.2	Granitic Gneiss	Axial	47	47	6.9	97
	B502-01	2	14.4	164.2	Granitic Gneiss	Diametral	106	47	14.3	200
	B502-01	2	15.2	163.4	Granitic Gneiss	Diametral	64	47	12.4	174
Pier 2	B502-10	1	50.6	127.9	Granitic Gneiss	Axial	34	45	9.3	130
	B502-10	1	50.7	127.8	Granitic Gneiss	Diametral	70	45	4.7	66
	B502-10	2	51.3	127.2	Granitic Gneiss	Axial	50	45	8.0	112
	B502-10	2	51.3	127.2	Granitic Gneiss	Diametral	97	45	7.3	102
	B502-10	3	53.0	125.5	Granitic Gneiss	Axial	40	45	9.4	132
	B502-10	3	53.0	125.5	Granitic Gneiss	Diametral	80	45	6.9	97
	B502-11	1	37.1	141.4	Granitic Gneiss	Axial	45	45	7.7	107
	B502-11	1	37.1	141.4	Granitic Gneiss	Diametral	97	45	10.1	142
	B502-11	1	37.1	141.4	Granitic Gneiss	Axial	49	45	8.1	113
	B502-11	2	38.7	139.8	Granitic Gneiss	Axial	31	45	3.4	48
	B502-11	3	39.8	138.7	Granitic Gneiss	Axial	40	45	1.7	24
	B502-11	3	39.8	138.7	Granitic Gneiss	Diametral	54	45	0.3	5

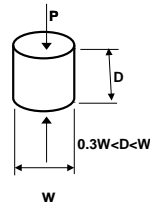
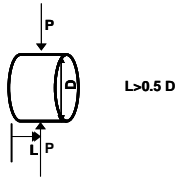
TABLE B1
POINT LOAD TEST RESULTS ON ROCK SAMPLES

Foundation Element	Borehole Number	Run Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Core Length (mm)	Core Diameter (mm) ⁽²⁾	Is (50mm) (MPa)	Approx. UCS Value ⁽¹⁾ (MPa)
Pier 3	B502-02	2	29.0	149.6	Granitic Gneiss	Axial	34	48	9.5	133
	B502-02	2	29.0	149.6	Granitic Gneiss	Diametral	97	48	5.6	79
	B502-02	3	30.2	148.4	Granitic Gneiss	Axial	40	47	10.8	151
	B502-02	3	30.2	148.4	Granitic Gneiss	Diametral	85	47	8.9	124
	B502-02	3	31.3	147.3	Granitic Gneiss	Axial	40	47	9.4	131
	B502-02	3	31.3	147.3	Granitic Gneiss	Diametral	90	47	7.9	111
Between Pier 3 and Pier 4	B502-12	1	15.5	163.8	Granitic Gneiss	Diametral	105	45	7.9	111
	B502-12	1	15.6	163.7	Granitic Gneiss	Axial	53	45	9.5	133
	B502-12	3	17.3	162.0	Granitic Gneiss	Diametral	115	45	4.7	65
Pier 4	B502-13	1	16.4	167.1	Granitic Gneiss	Diametral	160	45	7.2	101
	B502-13	2	17.2	166.3	Granitic Gneiss	Diametral	115	45	7.5	105

⁽¹⁾ $IS_{50} \times K$, from ASTM Designation: D 5731 "Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications". A value of $K = 14$ has been used based on 14 UCS tests for both the SBL and NBL bridges.

DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis
 (planes of weakness)



AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis
 (planes of weakness)

Compiled By: MCK/MT
 Checked By: AB
 Reviewed By: JPD/JMAC

TABLE B2-1
SUMMARY OF UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS
STRAIGHT LAKE NBL BRIDGE
HIGHWAY 69 GWP 5404-05-00; WP 5146-08-01

Borehole Number (Core Run)	Sample Depth (m)	Sample Elevation (m)	Rock Type	Core Diameter (mm)	Uniaxial Compressive Strength (MPa)
B502-01 (1)	13.1	165.5	Granitic Gneiss	47.4	68.1
B502-09 (3)	6.2	172.4	Granitic Gneiss	47.6	85.1
B502-11 (3)	39.1	139.4	Granitic Gneiss	47.4	22.7
B502-13 (2)	16.6	166.9	Granitic Gneiss	47.5	110.6

Compiled By: MTReviewed By: AB

Table B2-2

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****SAMPLE IDENTIFICATION**

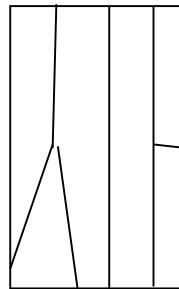
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 1
BOREHOLE NUMBER	B502-01	SAMPLE DEPTH, m	13.00-13.12

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.23

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.56	WATER CONTENT, (specimen) %	0.05
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m ³	27.60
SAMPLE AREA, cm ²	17.63	DRY UNIT WT., kN/m ³	27.59
SAMPLE VOLUME, cm ³	186.11	SPECIFIC GRAVITY	-
WET WEIGHT, g	524.00	VOID RATIO	-
DRY WEIGHT, g	523.74		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	68.1
----------------------	---	-------------------------	------

REMARKS:	DATE:	3/15/2013
----------	-------	-----------

Table B2-3

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****SAMPLE IDENTIFICATION**

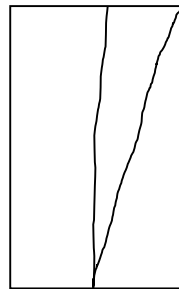
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 3
BOREHOLE NUMBER	B502-09	SAMPLE DEPTH, m	6.10-6.30

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.11

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.06	WATER CONTENT, (specimen) %	0.07
SAMPLE DIAMETER, cm	4.76	UNIT WEIGHT, kN/m ³	26.96
SAMPLE AREA, cm ²	17.78	DRY UNIT WT., kN/m ³	26.94
SAMPLE VOLUME, cm ³	178.85	SPECIFIC GRAVITY	-
WET WEIGHT, g	491.80	VOID RATIO	-
DRY WEIGHT, g	491.46		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	85.1
----------------------	---	-------------------------	------

REMARKS:

DATE:

4/17/2014

Table B2-4

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****SAMPLE IDENTIFICATION**

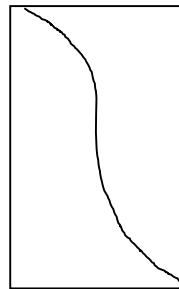
PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 3
BOREHOLE NUMBER	B502-11	SAMPLE DEPTH, m	38.98-39.16

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.10

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	9.97	WATER CONTENT, (specimen) %	1.30
SAMPLE DIAMETER, cm	4.74	UNIT WEIGHT, kN/m ³	26.70
SAMPLE AREA, cm ²	17.63	DRY UNIT WT., kN/m ³	26.35
SAMPLE VOLUME, cm ³	175.80	SPECIFIC GRAVITY	-
WET WEIGHT, g	478.74	VOID RATIO	-
DRY WEIGHT, g	472.60		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	22.7
----------------------	---	-------------------------	------

REMARKS:

DATE:

4/17/2014

Table B2-5

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****SAMPLE IDENTIFICATION**

PROJECT NUMBER	09-1111-6014	SAMPLE NUMBER	Run 2
BOREHOLE NUMBER	B502-13	SAMPLE DEPTH, m	16.52-16.74

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.20

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.47	WATER CONTENT, (specimen) %	0.08
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m ³	26.15
SAMPLE AREA, cm ²	17.70	DRY UNIT WT., kN/m ³	26.13
SAMPLE VOLUME, cm ³	185.23	SPECIFIC GRAVITY	-
WET WEIGHT, g	494.15	VOID RATIO	-
DRY WEIGHT, g	493.75		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	110.6
----------------------	---	-------------------------	-------

REMARKS:

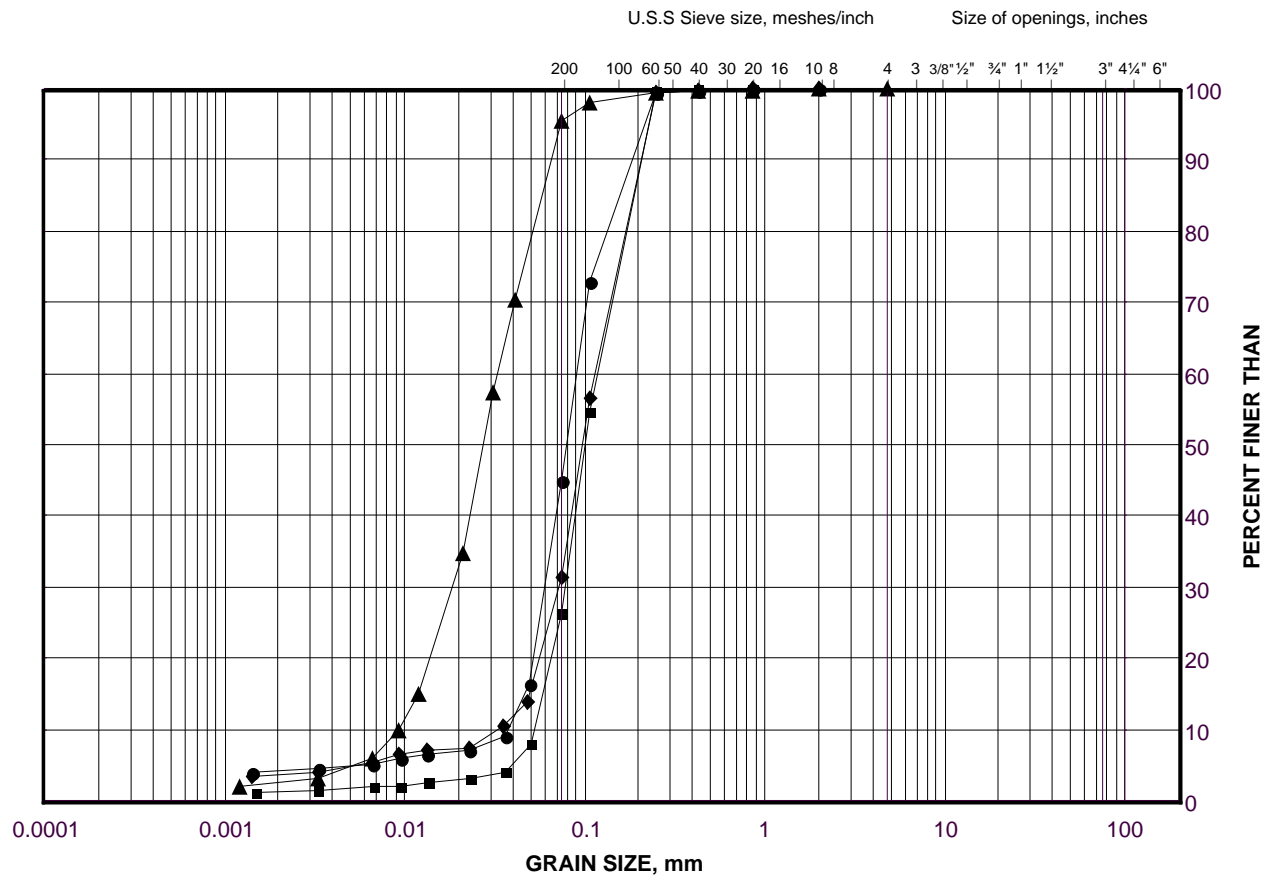
DATE:

4/17/2014

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand

FIGURE B1-A



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B502-04	3	183.9
■	B502-06	3	184.3
◆	B502-05	3	183.9
▲	B502-01	8	166.4

Silt to Sand

FIGURE B1-B



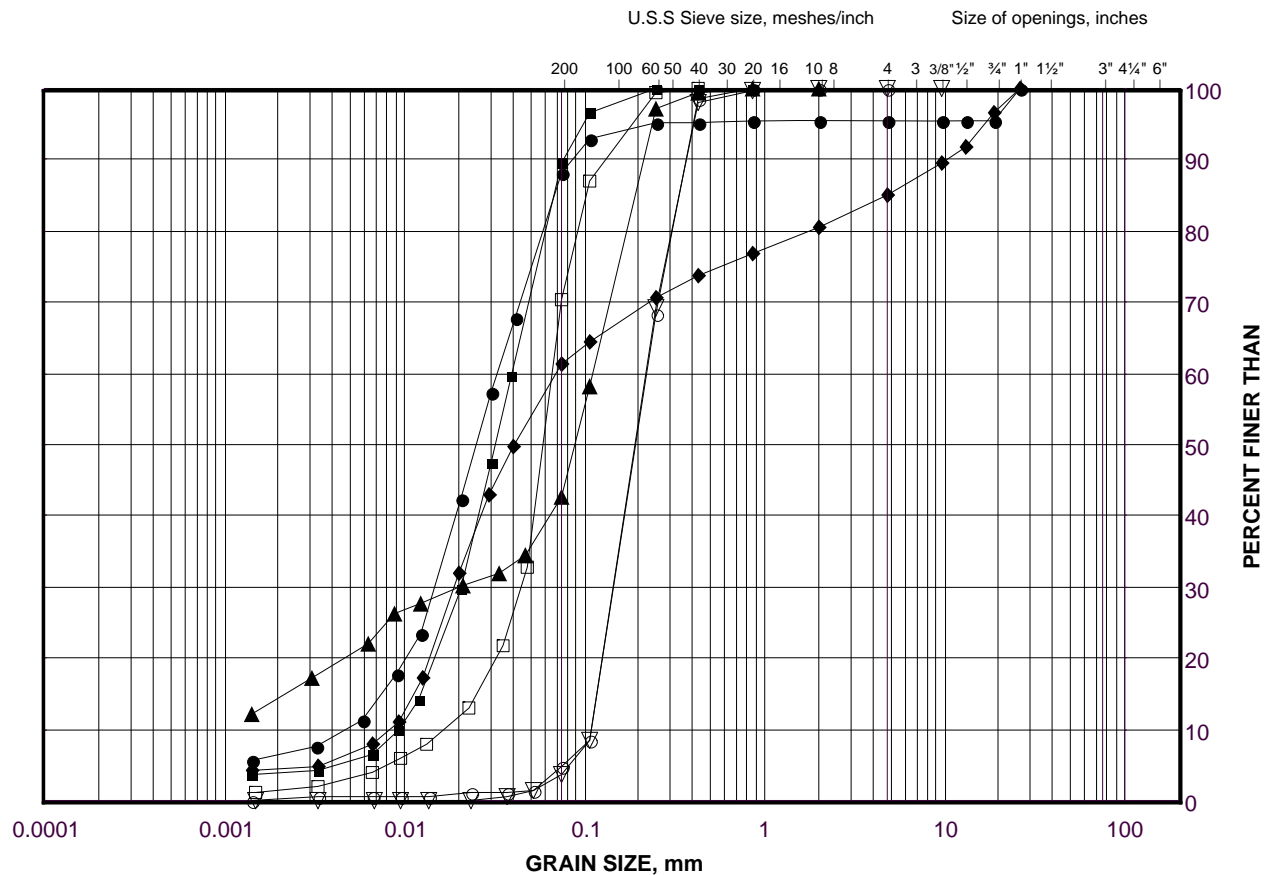
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B502-11	10	167.5
■	B502-10	16	155.6
◆	B502-10	18	151.1
▲	B502-07	3	184.7
▽	B502-08	3	184.6
○	B502-10	9	166.3

Date: 28-Jun-16

GRAIN SIZE DISTRIBUTION

Silt to Sand

FIGURE B1-C



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B502-13	13	171.2
■	B502-11	18	153.8
◆	B502-11	22	141.8
▲	B502-16	3	173.4
▽	B502-13	5	180.9
○	S502-20	5	180.8
□	S502-20	6	180.0

Project Number: 09-1111-6014

Checked By: AB/JMAC

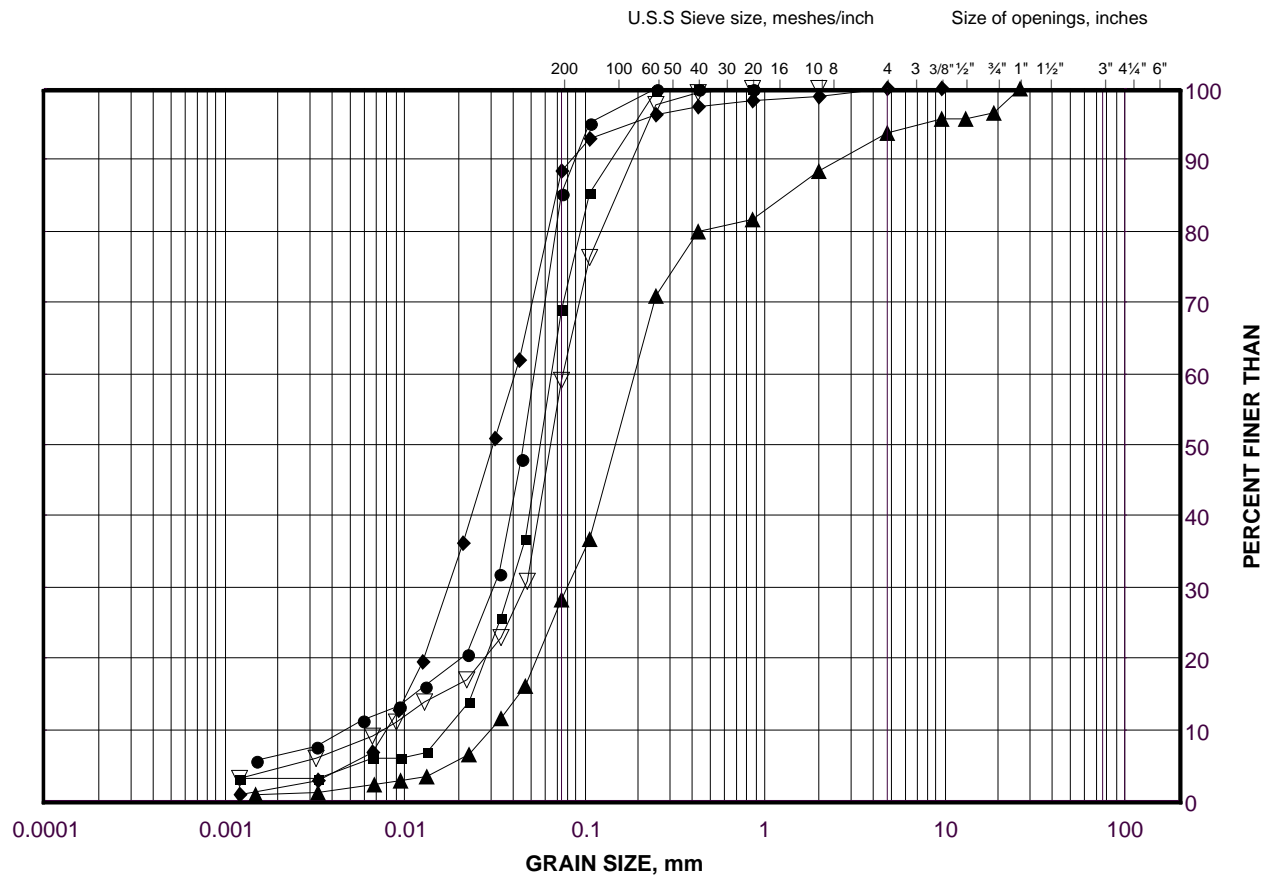
Golder Associates

Date: 26-Nov-15

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand

FIGURE B1-D



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-20	11B	172.9
■	S502-20	12	171.6
◆	B502-02	16	154.4
▲	B502-11	20	147.7
▽	B502-02	8	168.1

Project Number: 09-1111-6014

Checked By: AB/JMAC

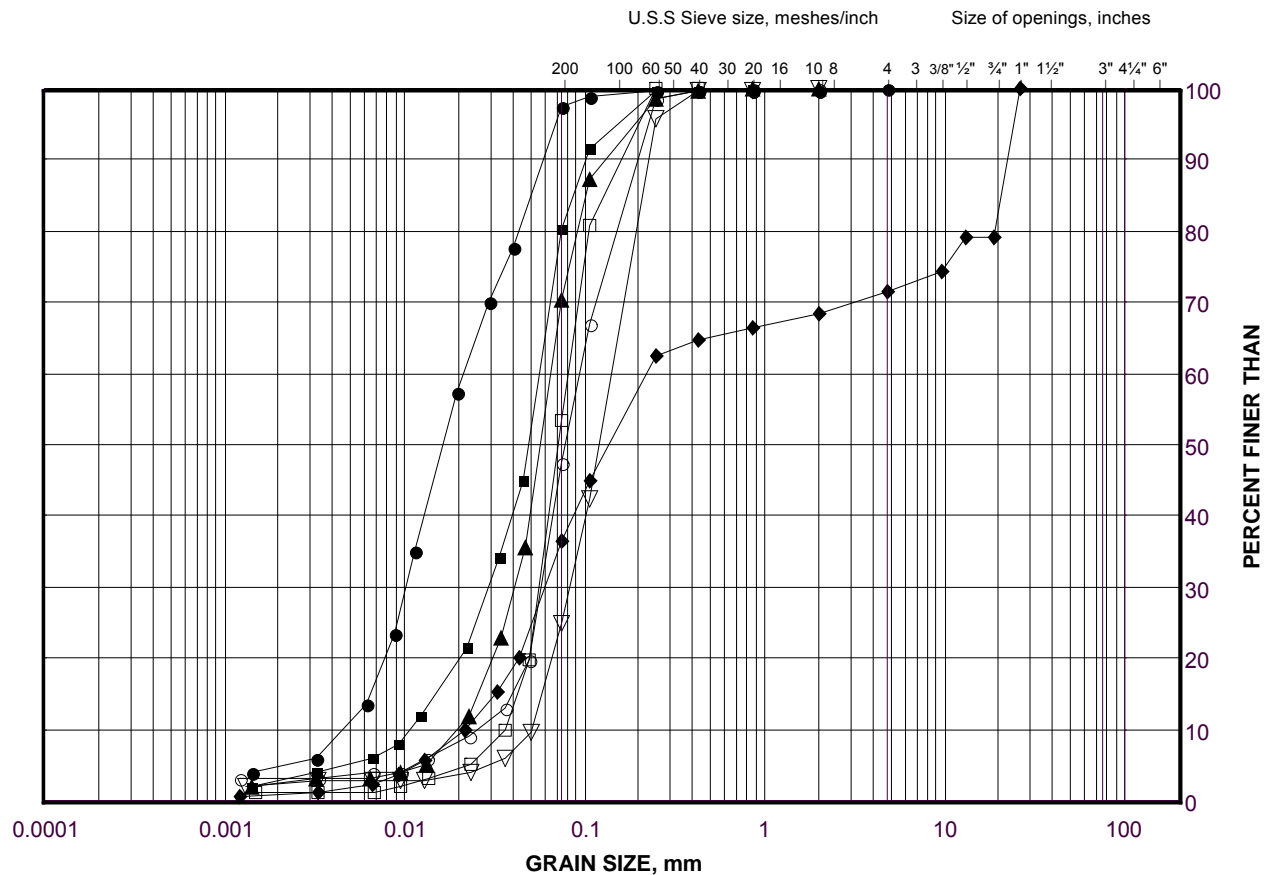
Golder Associates

Date: 30-Jun-16

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand

FIGURE B1-E



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-18	12	168.8
■	S502-18	13	167.3
◆	B502-02	17	151.3
▲	B502-14	3	184.5
▽	S502-22	4	185.4
○	S502-18	4	178.7
□	B502-14	8	178.4

Project Number: 09-1111-6014

Checked By: AB/JMAC

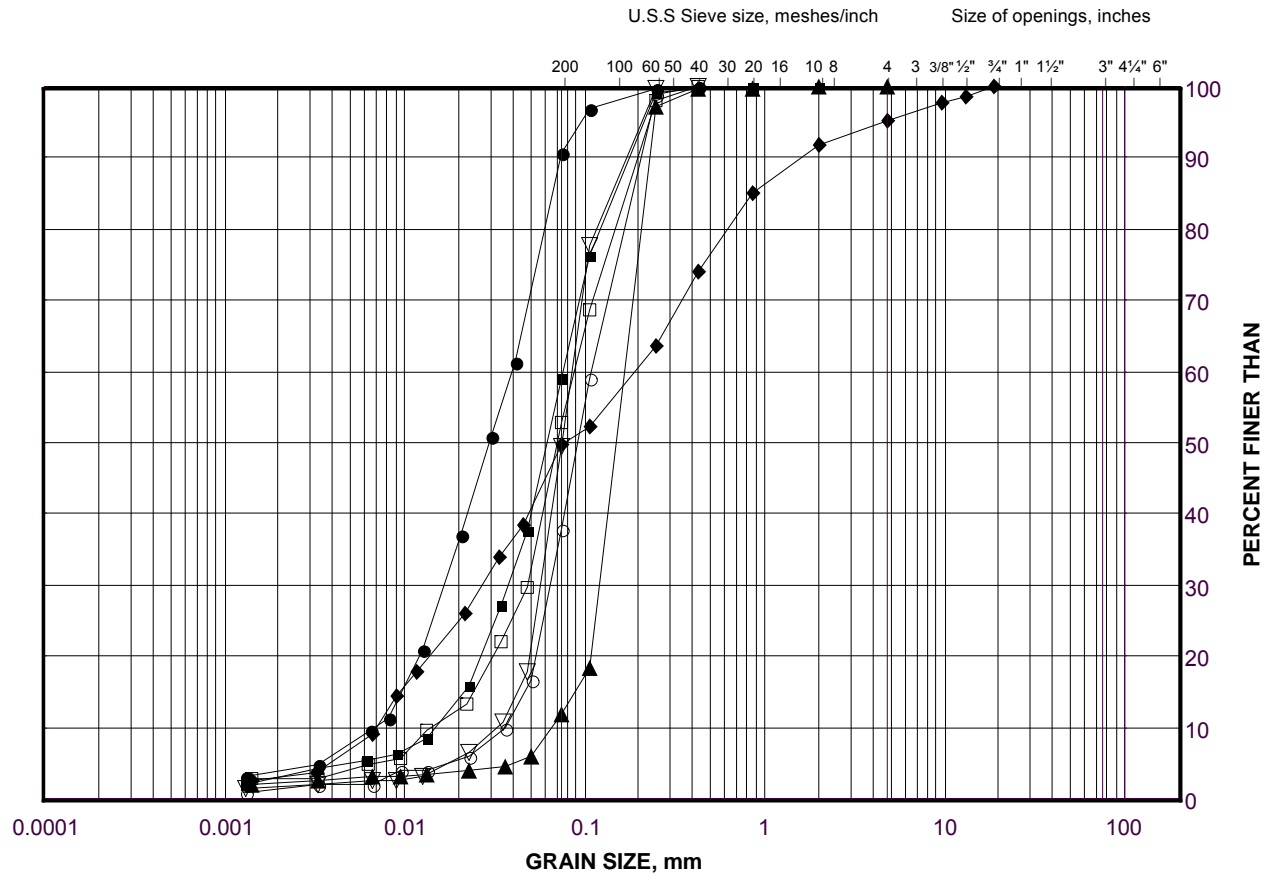
Golder Associates

Date: 07-Jan-16

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand

FIGURE B1-F



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-22	13	174.0
■	S502-22	15	170.9
◆	S502-24	15	173.2
▲	S502-24	4	187.7
▽	S502-22	5	184.7
○	S502-24	8	183.9
□	S502-24	9	182.4

Project Number: 09-1111-6014

Checked By: AB/JMAC

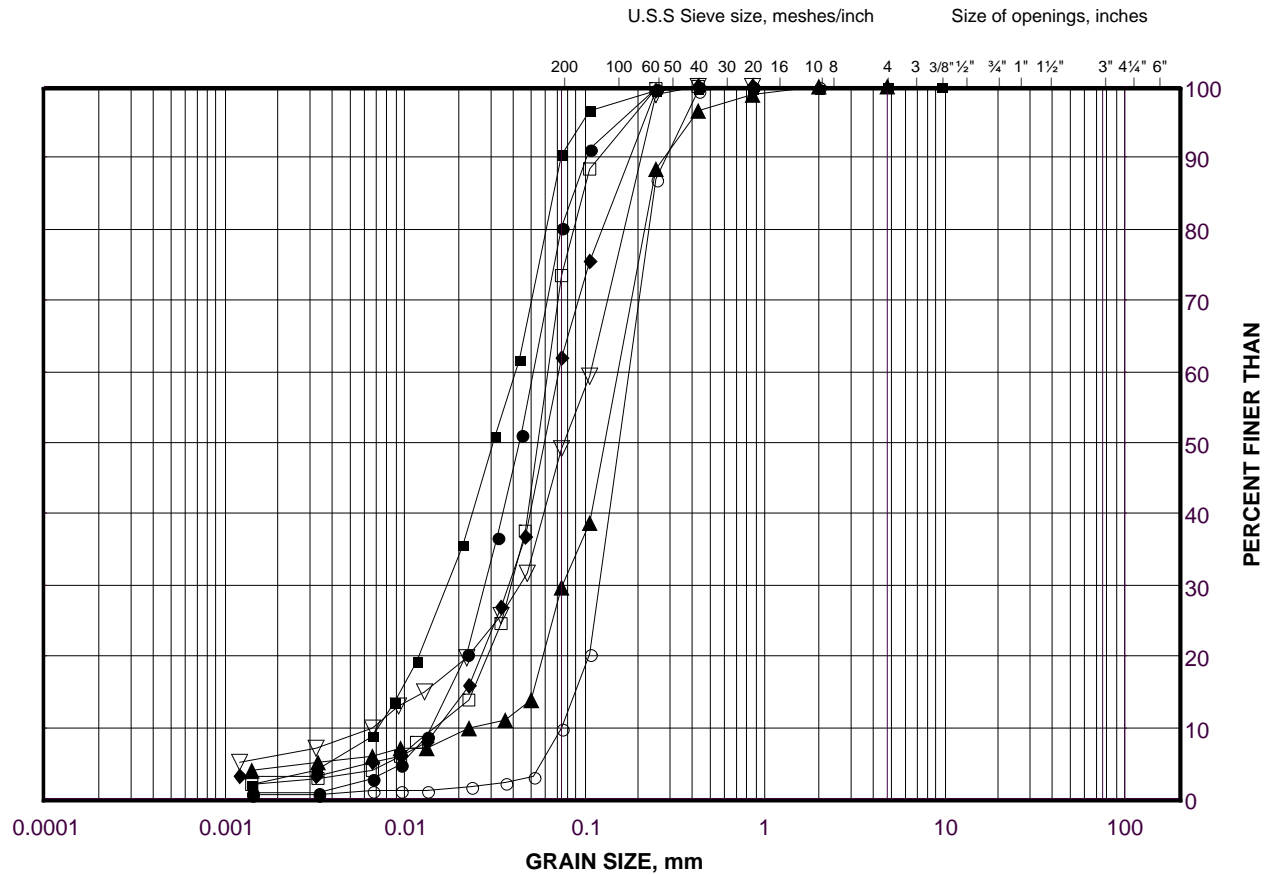
Golder Associates

Date: 08-Jan-16

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand

FIGURE B1-G



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-21	13	173.6
■	S502-08	14	175.1
◆	S502-08	16	172.0
▲	S502-21	3	185.7
▽	S502-21	7	182.7
○	S502-08	7	185.8
□	S502-08	8	184.2

Project Number: 09-1111-6014

Checked By: _____

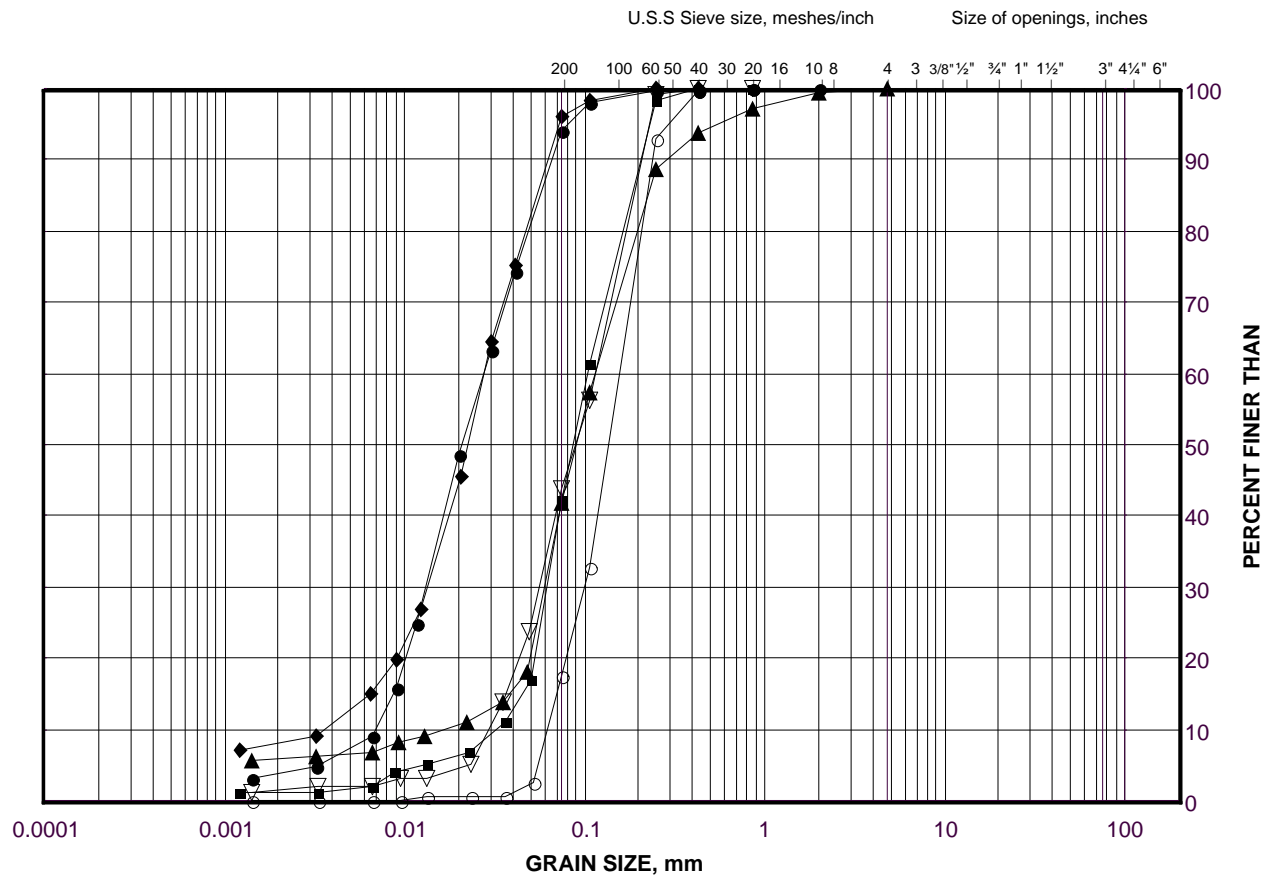
Golder Associates

Date: 12-Apr-16

GRAIN SIZE DISTRIBUTION

Silt to Silty Sand

FIGURE B1-H



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-20A	10	175.2
■	S502-23	10	179.3
◆	S502-18	11B	170.1
▲	S502-23	3	186.9
▽	S502-23	6	184.6
○	S502-23	7	183.8

Project Number: 09-1111-6014

Checked By: _____

Golder Associates

Date: 13-Apr-16

Silt and Sand

FIGURE B1-I



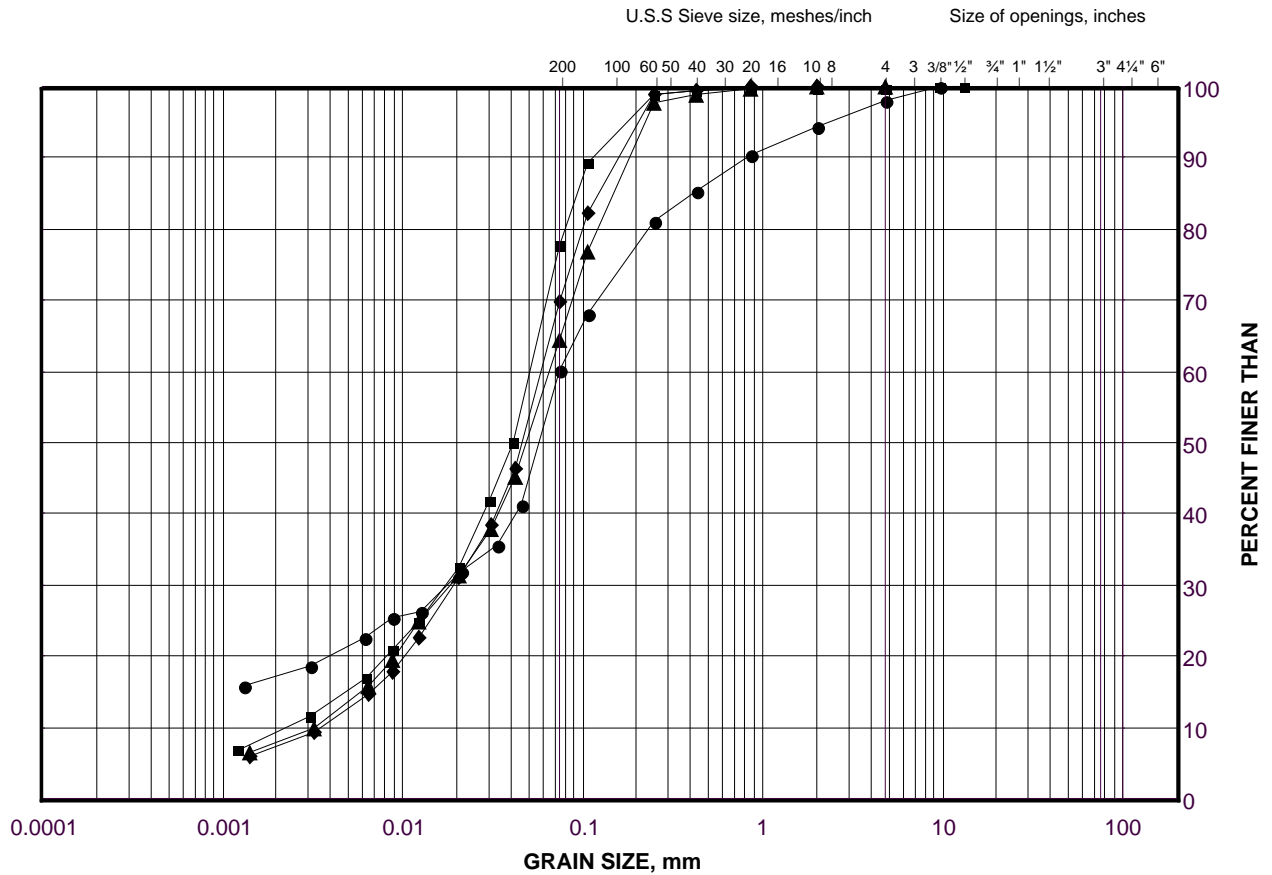
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S502-12	11	181.1
■	S502-12	4	189.5
◆	S502-12	6A	188.1
▲	S502-12	7	187.2

Date: 19-May-16

GRAIN SIZE DISTRIBUTION

Organic Silt to Organic Silt and Sand

FIGURE B1-J



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

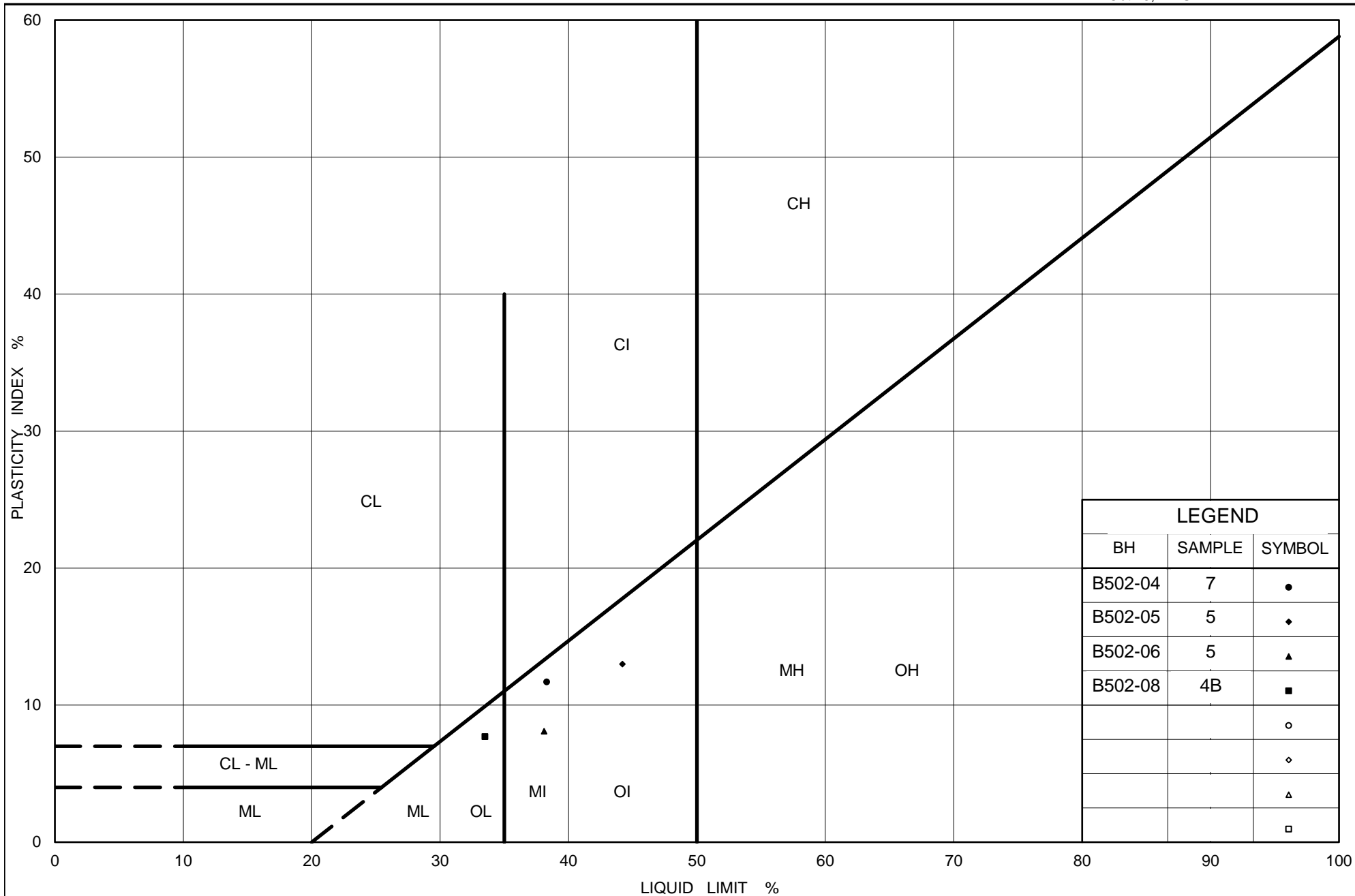
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B502-07	5	183.2
■	B502-05	5	182.4
◆	B502-06	5	182.7
▲	B502-04	7	180.8

Project Number: 09-1111-6014

Checked By: AB/JMAC

Golder Associates

Date: 28-Jun-16



Ministry of Transportation

Ontario

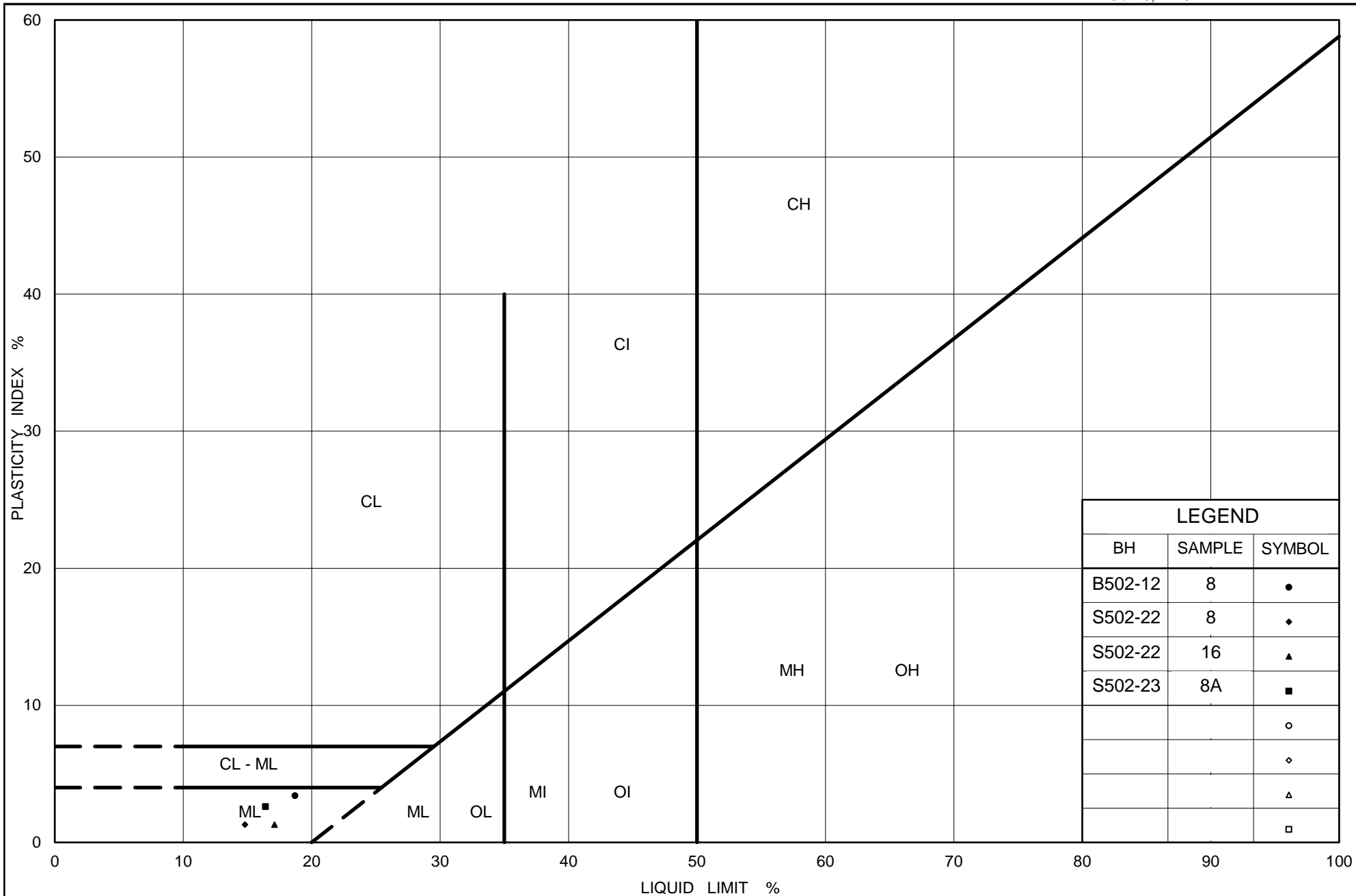
PLASTICITY CHART

Organic Silt

Figure No. B2-A

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

Ontario

PLASTICITY CHART

Silt (Interlayer) to Silt and Sand

Figure No. B2-B

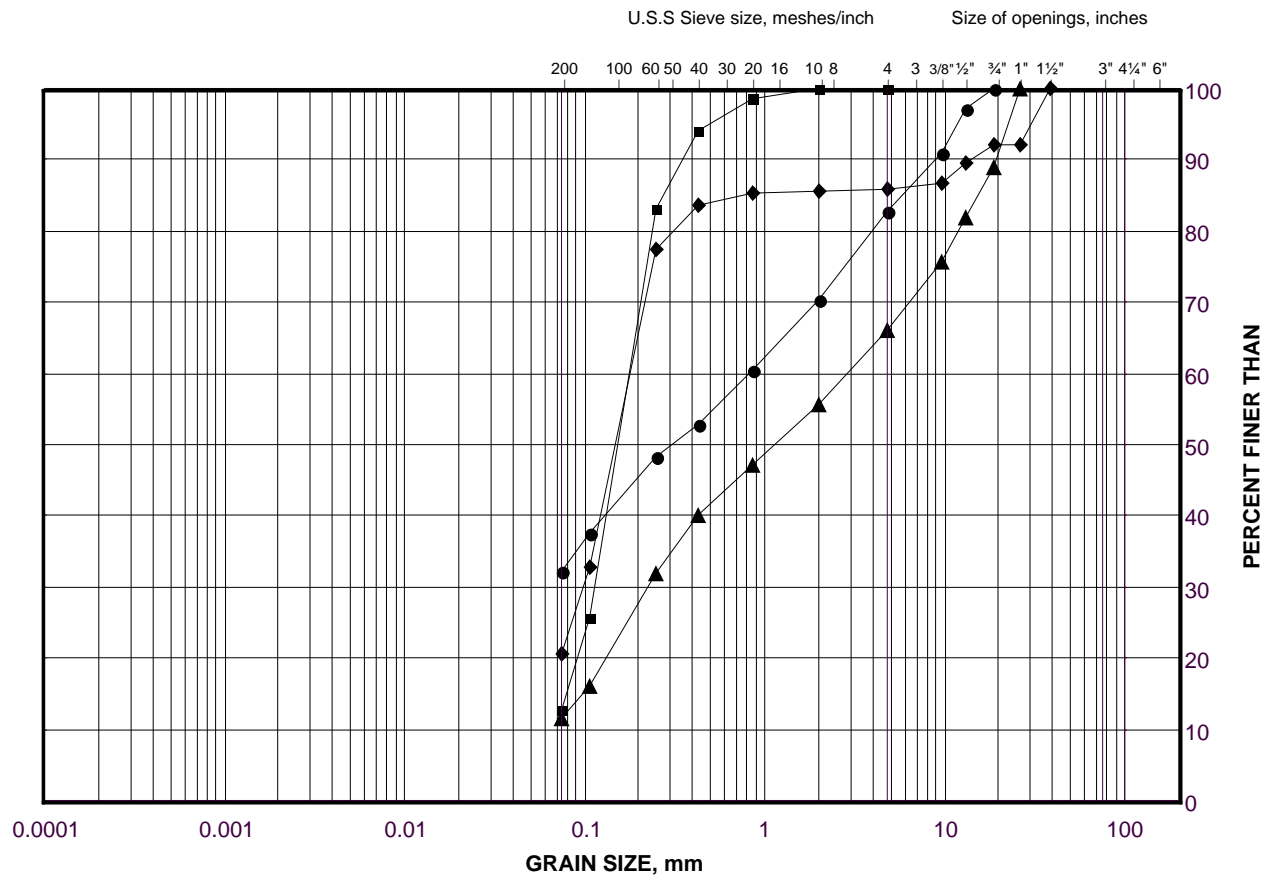
Project No. 09-1111-6014

Checked By: AB/JMAC

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand and Gravel

FIGURE B3



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

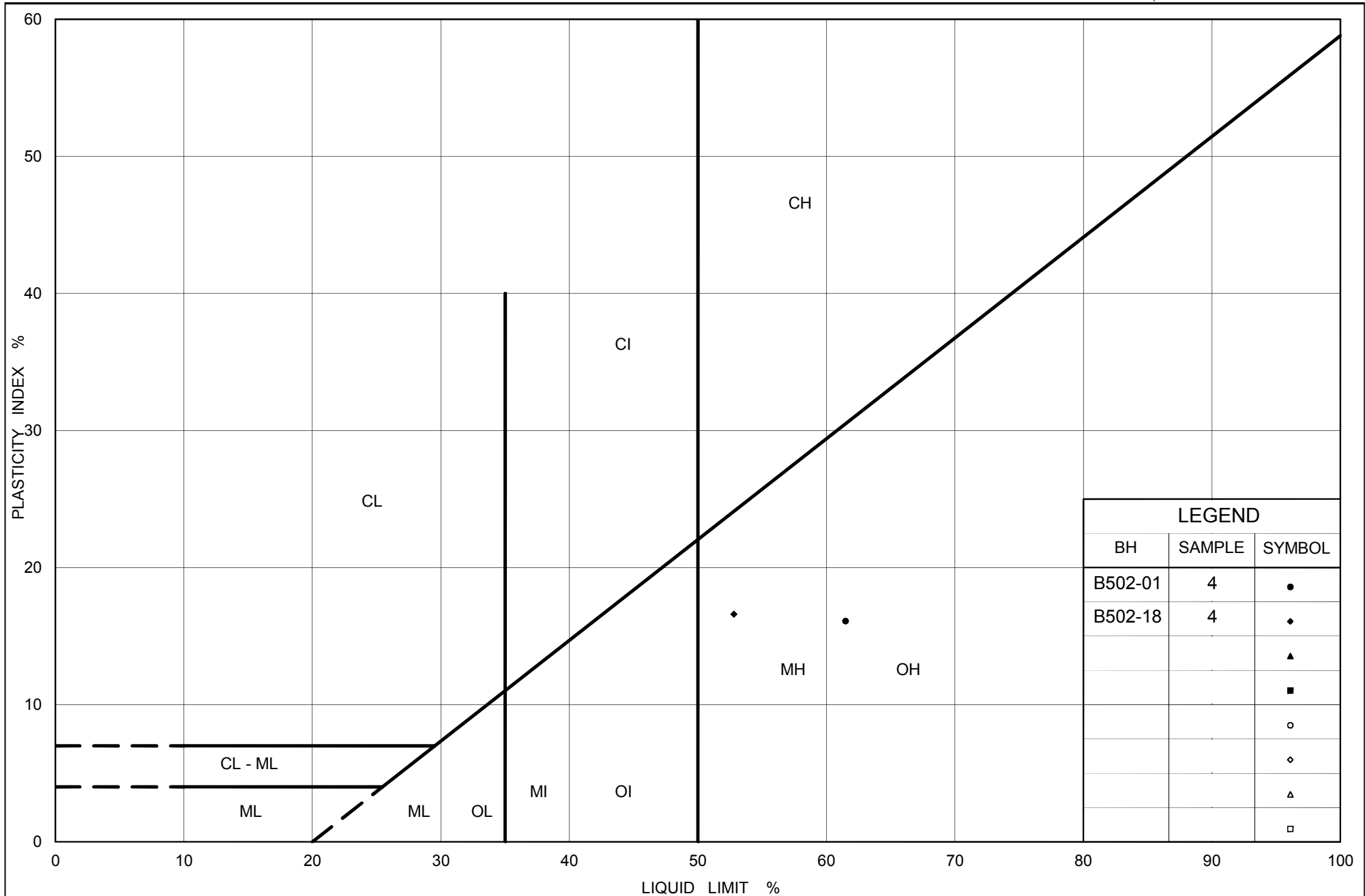
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B502-04	11	177.9
■	B502-10	20	145.0
◆	B502-10	22	138.9
▲	B502-06	8	180.5

Project Number: 09-1111-6014

Checked By: AB/JMAC

Golder Associates

Date: 30-Jun-16



Ministry of Transportation

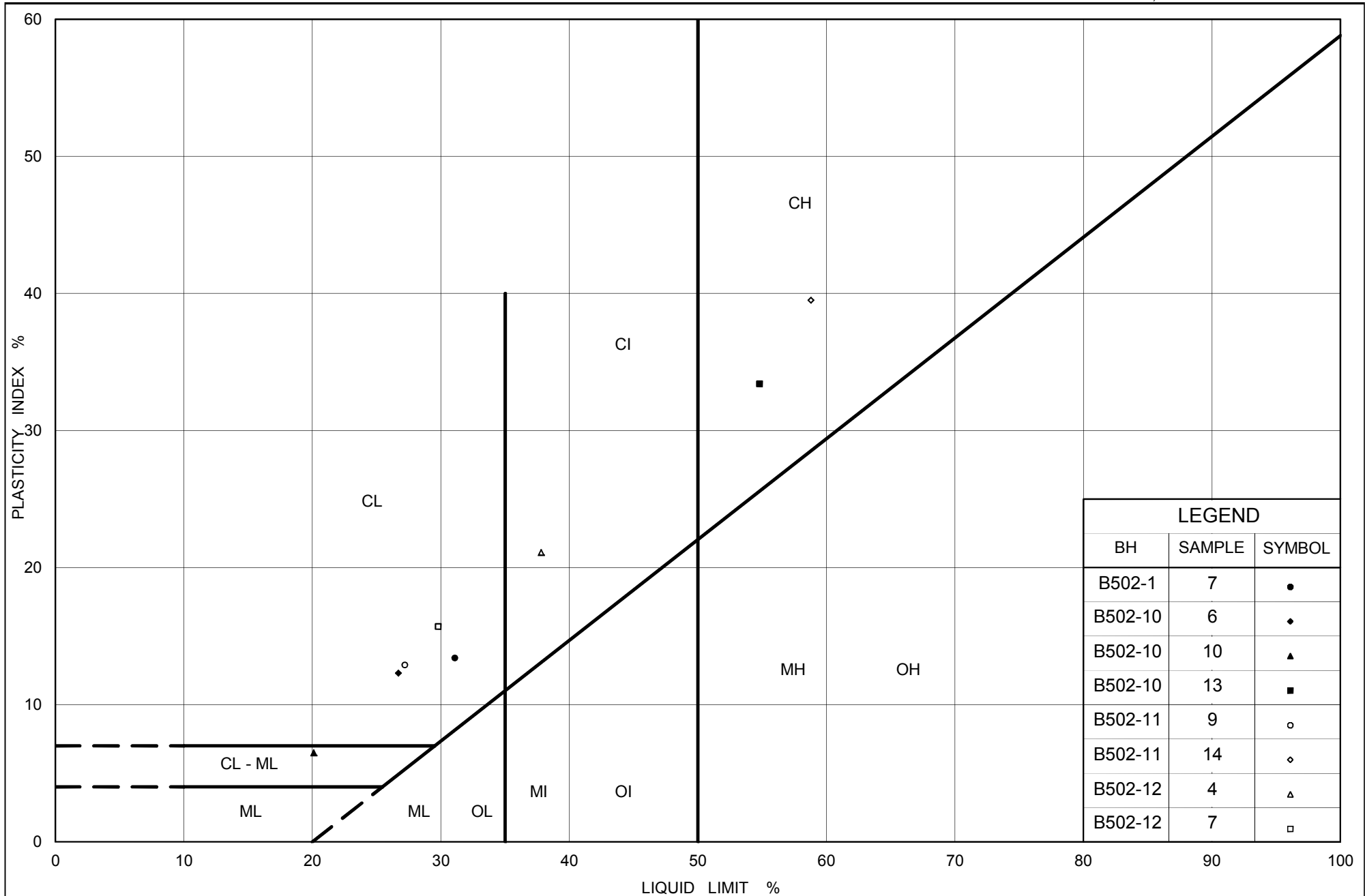
Ontario

PLASTICITY CHART Organic Silt

Figure No. B4

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

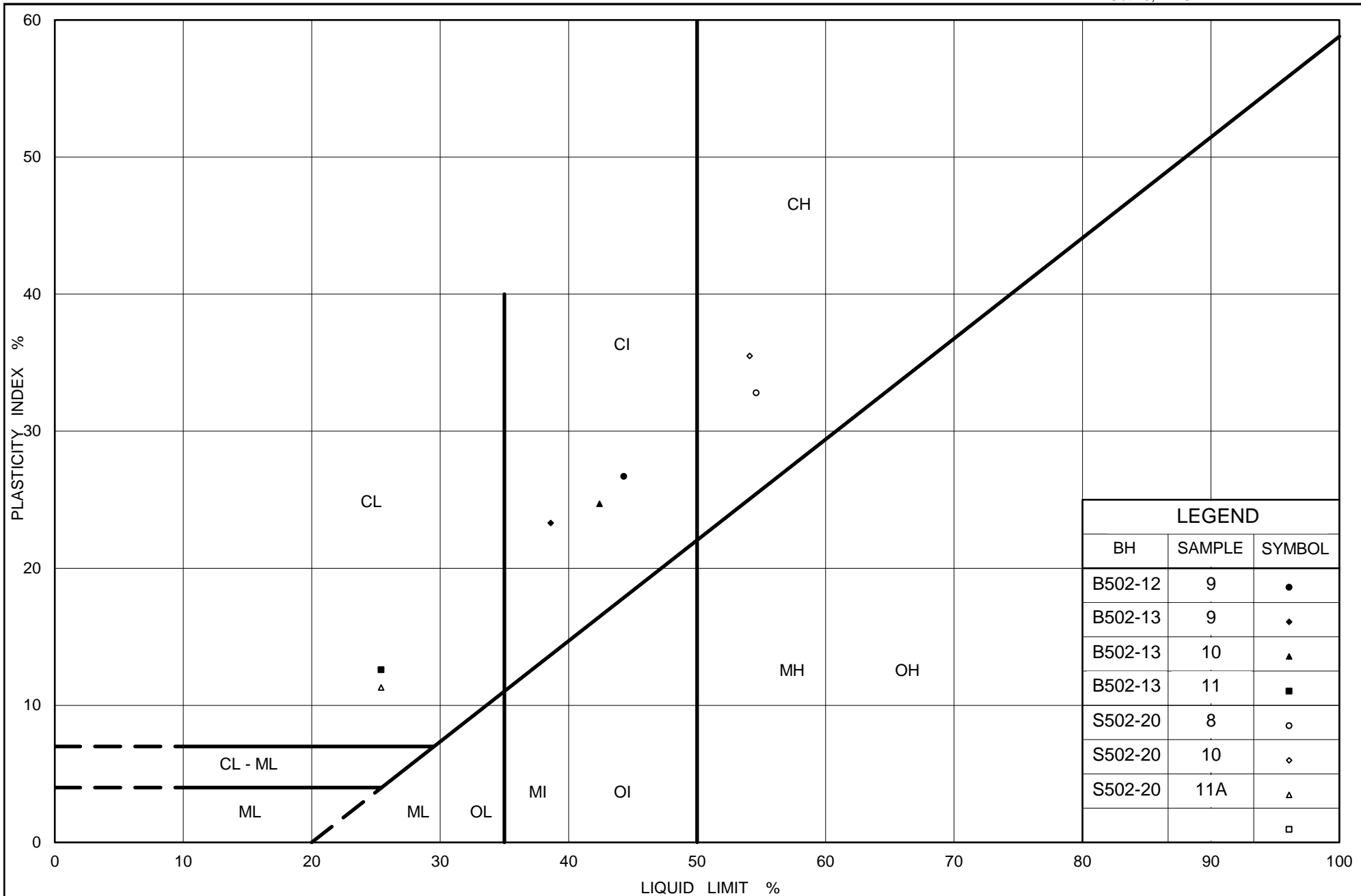
Ontario

PLASTICITY CHART Clayey Silt to Clay

Figure No. B5-A

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

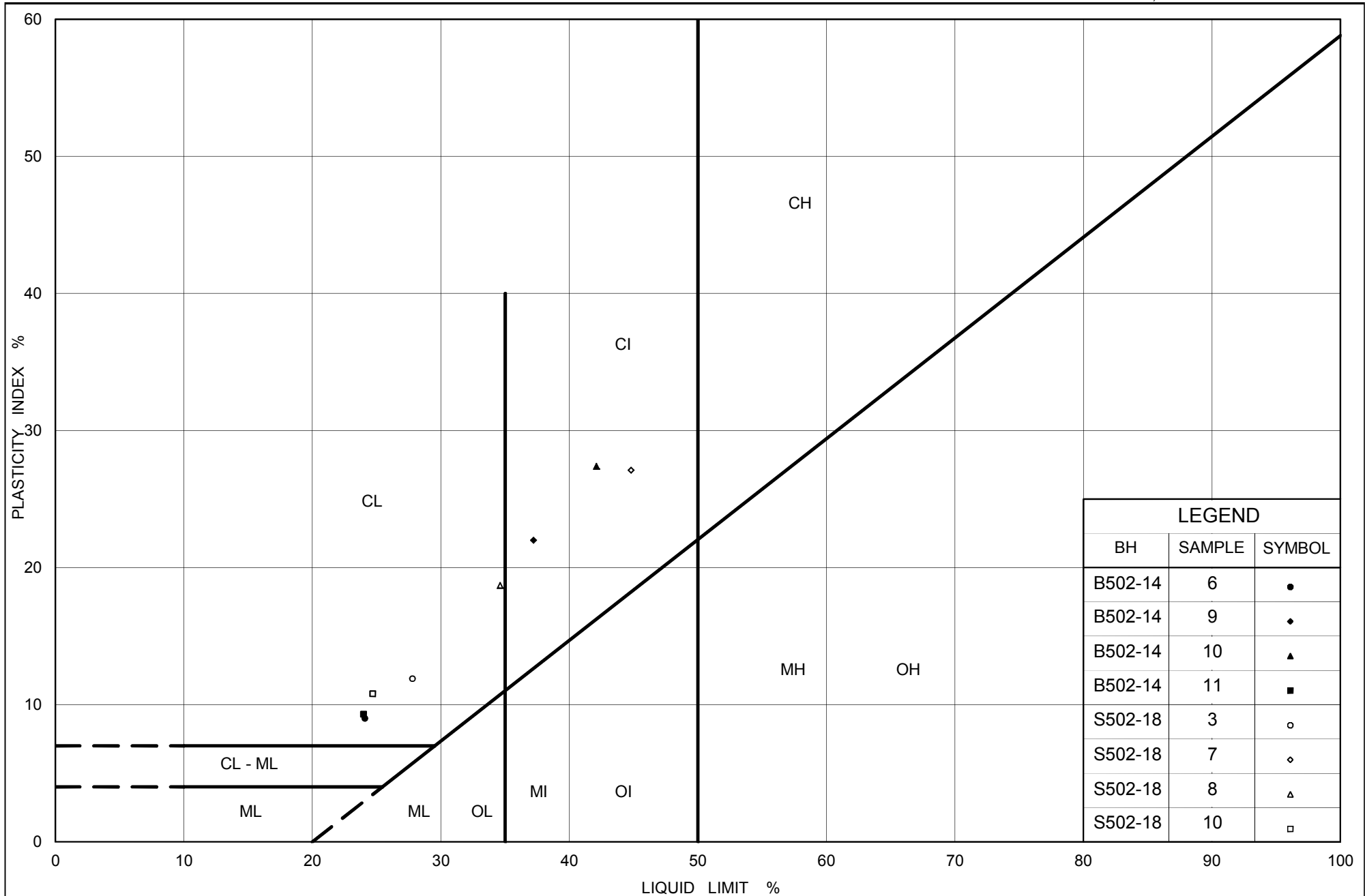
Ontario

PLASTICITY CHART Clayey Silt to Clay

Figure No. B5-B

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

Ontario

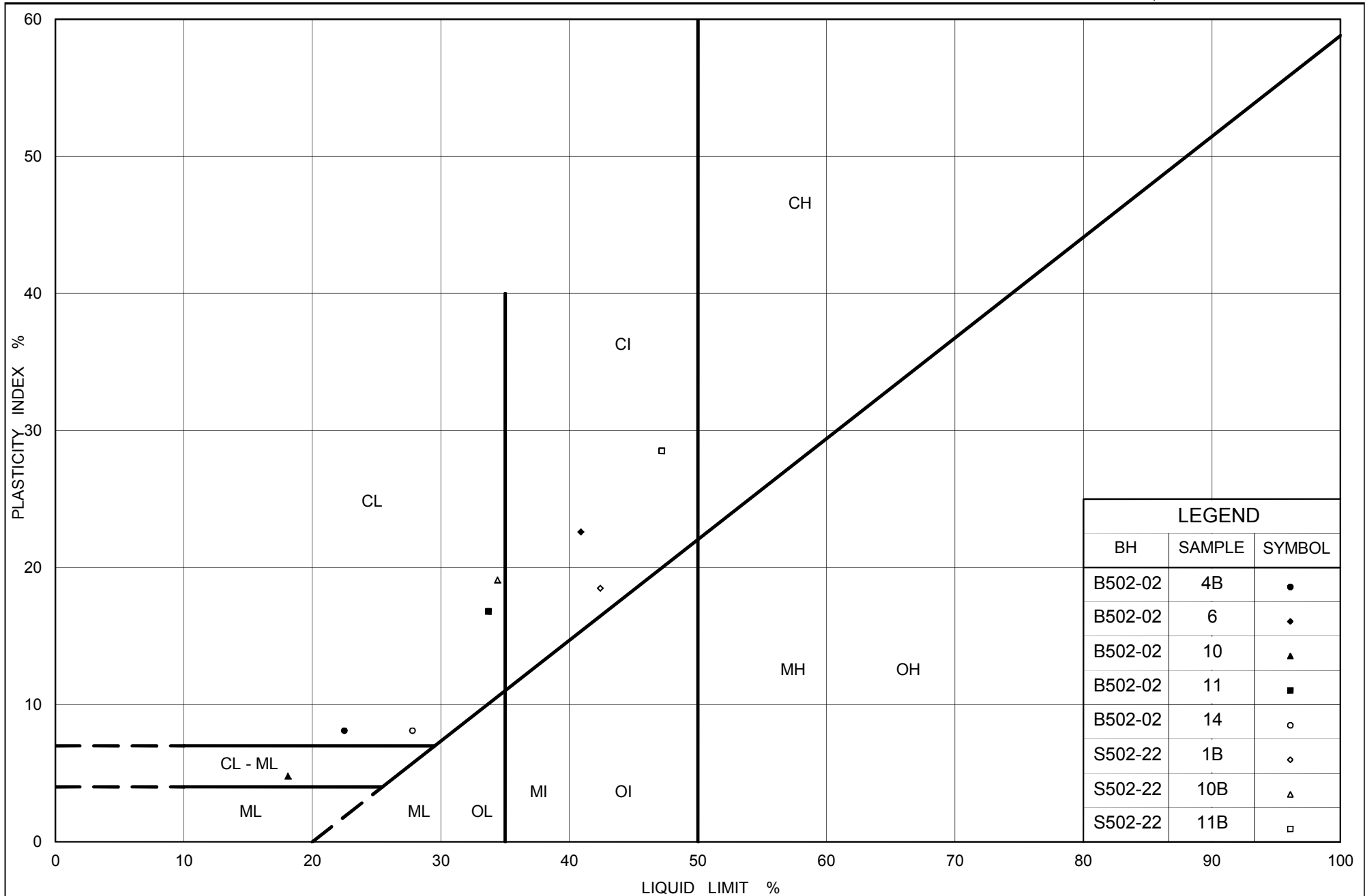
PLASTICITY CHART

Clayey Silt to Silty Clay

Figure No. B5-C

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

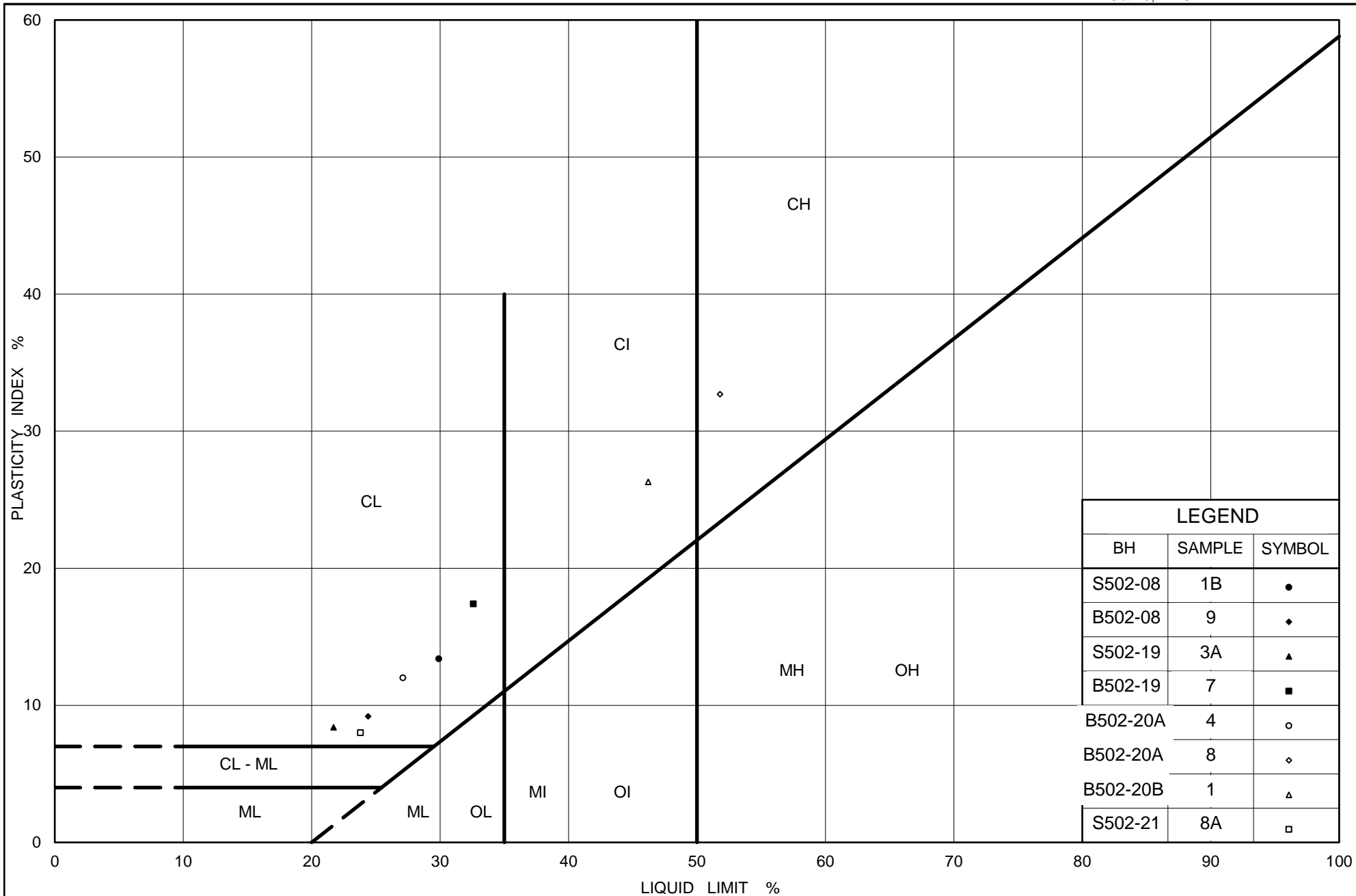
Ontario

PLASTICITY CHART Clayey Silt to Silty Clay

Figure No. B5-D

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

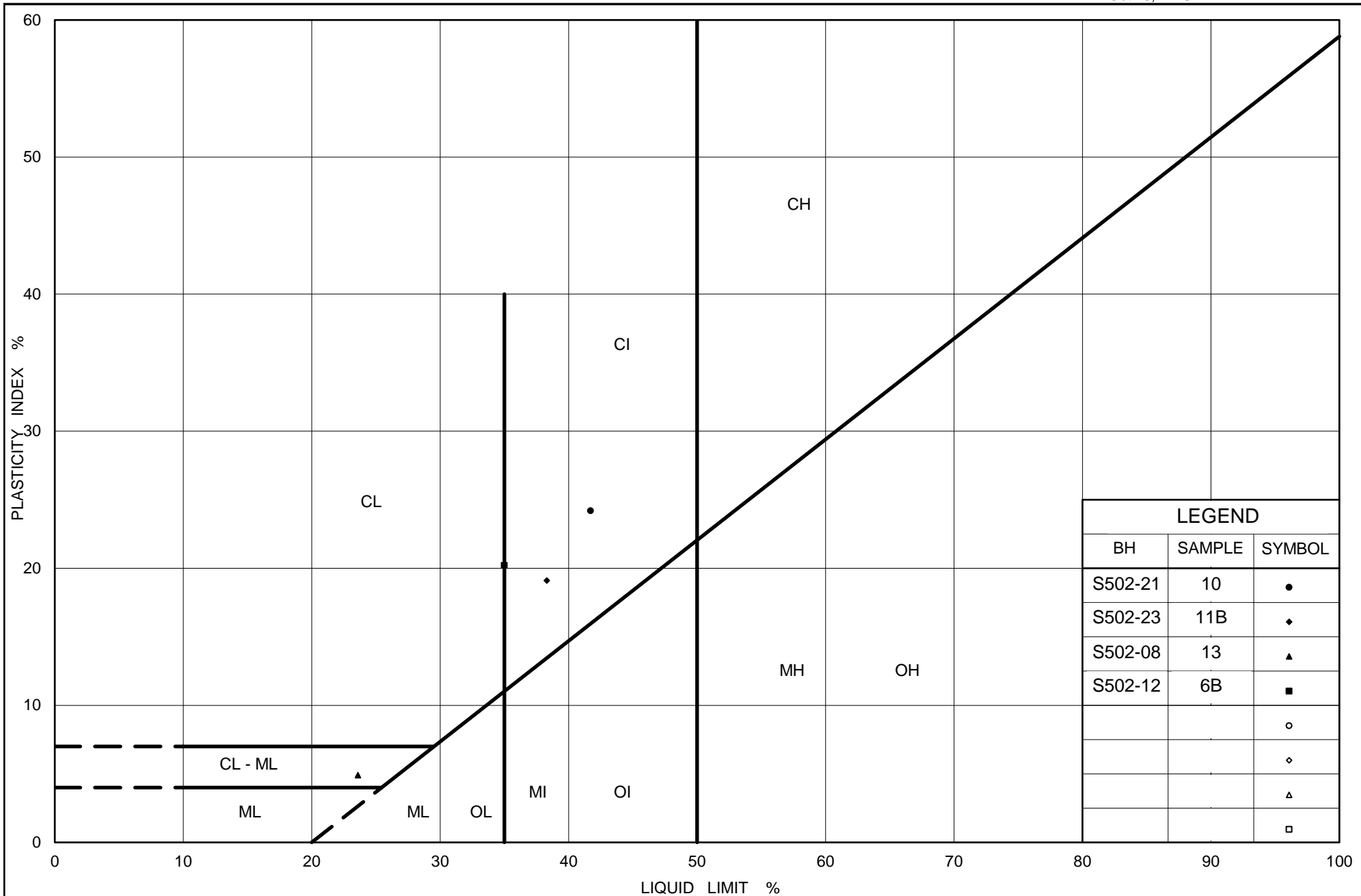
Ontario

PLASTICITY CHART Clayey Silt to Silty Clay

Figure No. B5-E

Project No. 09-1111-6014

Checked By: AB/JMAC



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt to Silty Clay

Figure No. B5-F

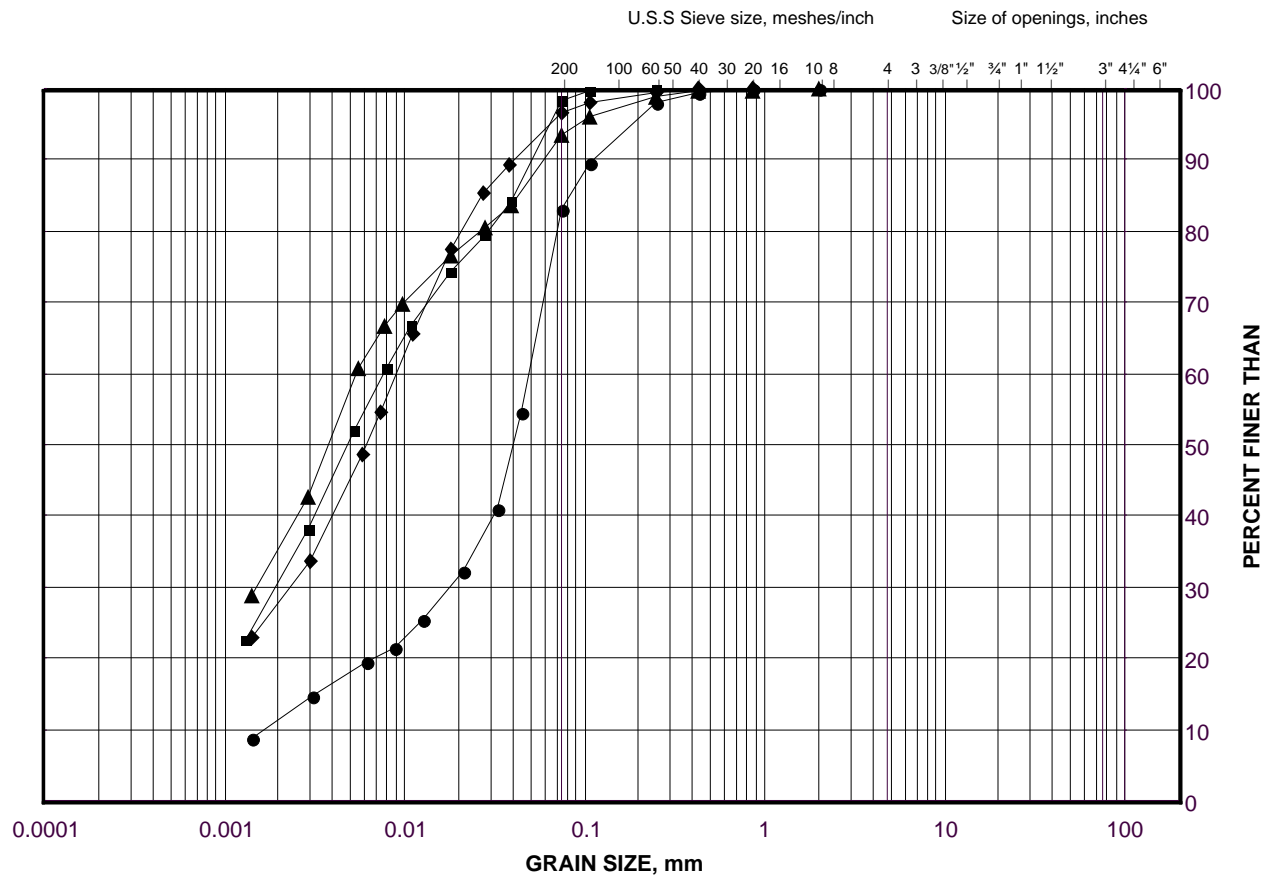
Project No. 09-1111-6014

Checked By: AB/JMAC

GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE B6



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	B502-02	10	165
■	B502-02	11	163.7
◆	S502-20A	4	181.8
▲	B502-12	7	171.7

Project Number: 09-1111-6014

Checked By: _____

Golder Associates

Date: 13-Apr-16

CONSOLIDATION TEST SUMMARY**FIGURE B7**

Sheet 1 of 4

SAMPLE IDENTIFICATION

Project Number	09-1111-6014	Sample Number	10
Borehole Number	B502-13	Sample Depth, m	7.47-7.92

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	8		
Date Started	3/18/2013		
Date Completed	3/31/2014		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m ³	17.57
Sample Diameter, cm	6.30	Dry Unit Weight, kN/m ³	12.11
Area, cm ²	31.19	Specific Gravity, measured	2.76
Volume, cm ³	59.27	Solids Height, cm	0.850
Water Content, %	45.07	Volume of Solids, cm ³	26.51
Wet Mass, g	106.16	Volume of Voids, cm ³	32.75
Dry Mass, g	73.18	Degree of Saturation, %	100.7

TEST COMPUTATIONS

Stress	Corr. Height	Void	Average Height	t ₉₀	cv.	mv	k
kPa	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	1.900	1.235	1.900				
6.35	1.903	1.238	1.901	11	6.97E-02		
11.33	1.902	1.238	1.902	231	3.32E-03	5.71E-05	1.86E-08
21.23	1.900	1.235	1.901	638	1.20E-03	1.06E-04	1.25E-08
40.93	1.891	1.224	1.895	1134	6.72E-04	2.56E-04	1.69E-08
80.23	1.874	1.204	1.882	1329	5.65E-04	2.24E-04	1.24E-08
158.60	1.846	1.171	1.860	1192	6.15E-04	1.90E-04	1.15E-08
319.05	1.697	0.997	1.772	3244	2.05E-04	4.86E-04	9.77E-09
632.89	1.547	0.820	1.622	1745	3.20E-04	2.52E-04	7.90E-09
1262.00	1.435	0.688	1.491	919	5.13E-04	9.39E-05	4.72E-09
2517.59	1.335	0.571	1.385	919	4.42E-04	4.18E-05	1.81E-09
1262.00	1.347	0.585	1.341				
319.05	1.368	0.609	1.357				
80.23	1.405	0.653	1.386				
21.23	1.436	0.689	1.421				
6.35	1.467	0.726	1.452				

Note:

Specimen taken 12-19 cm from bottom of the tube

k calculated using cv based on σ_0 values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.47	Unit Weight, kN/m ³	19.91
Sample Diameter, cm	6.30	Dry Unit Weight, kN/m ³	15.68
Area, cm ²	31.19	Specific Gravity, measured	2.76
Volume, cm ³	45.76	Solids Height, cm	0.850
Water Content, %	26.93	Volume of Solids, cm ³	26.51
Wet Mass, g	92.89	Volume of Voids, cm ³	19.24
Dry Mass, g	73.18		

Prepared By: RD

Golder Associates

Checked By: AV

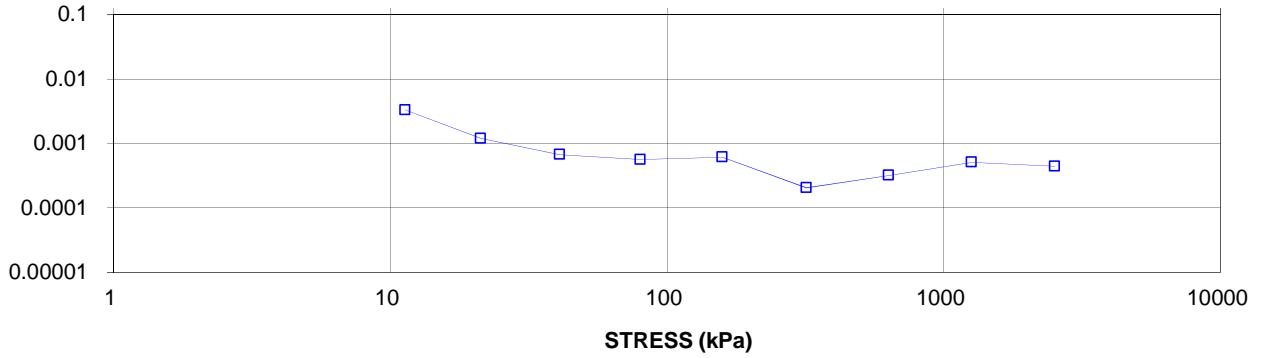
CONSOLIDATION TEST SUMMARY

FIGURE B7

Sheet 2 of 4

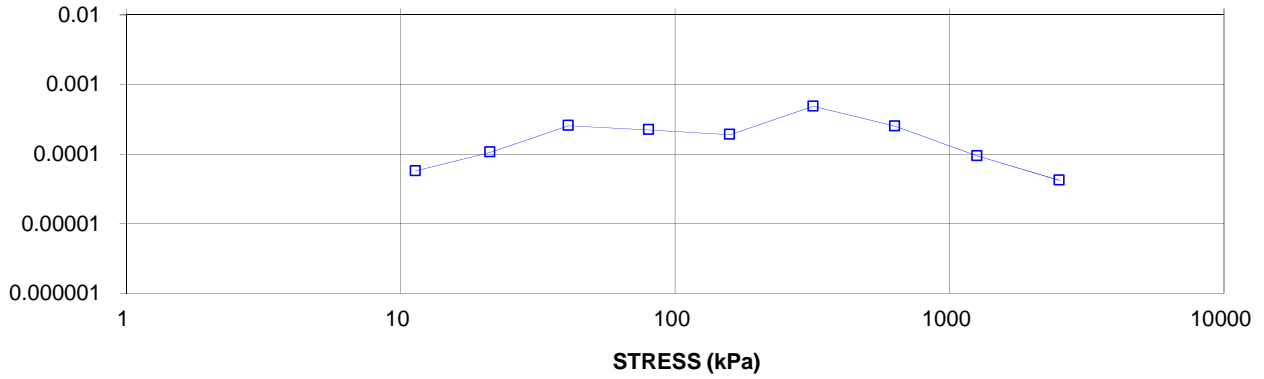
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH B502-13 SA 10



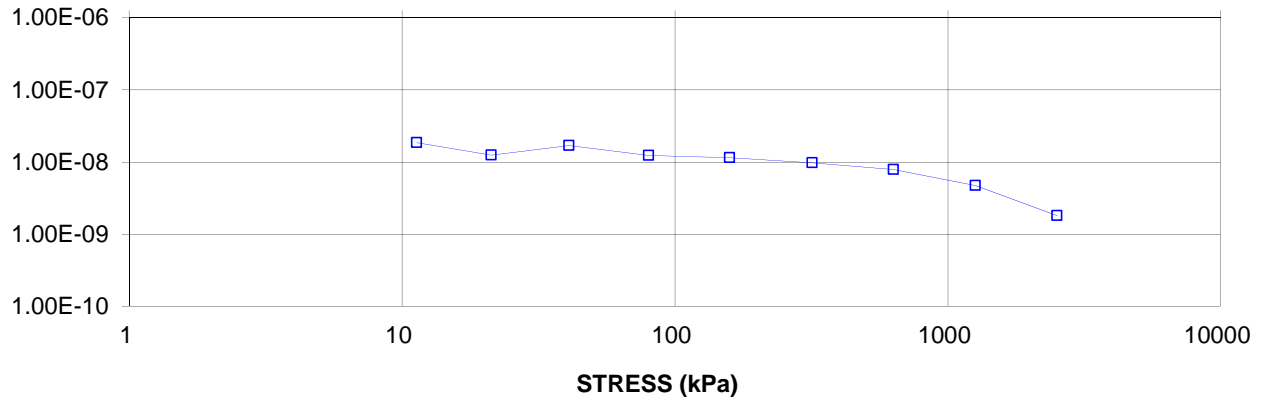
VOLUME COMPRESSIBILITY, m²/kN

CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH B502-13 SA 10



HYDRAULIC CONDUCTIVITY,
cm/s

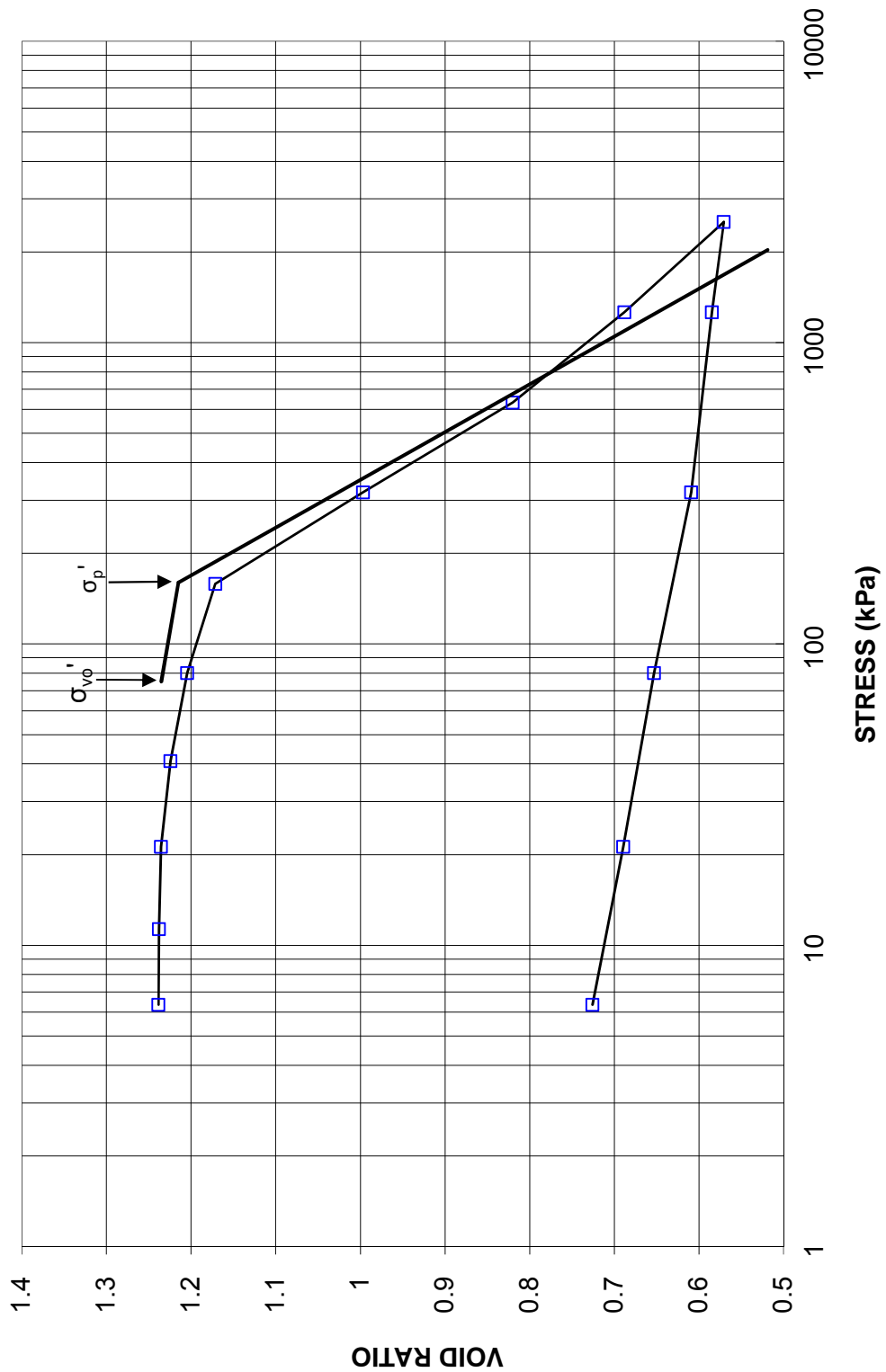
CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH B502-13 SA 10



**CONSOLIDATION TEST
VOID RATIO VS LOG STRESS**

FIGURE B7
Sheet 3 of 4

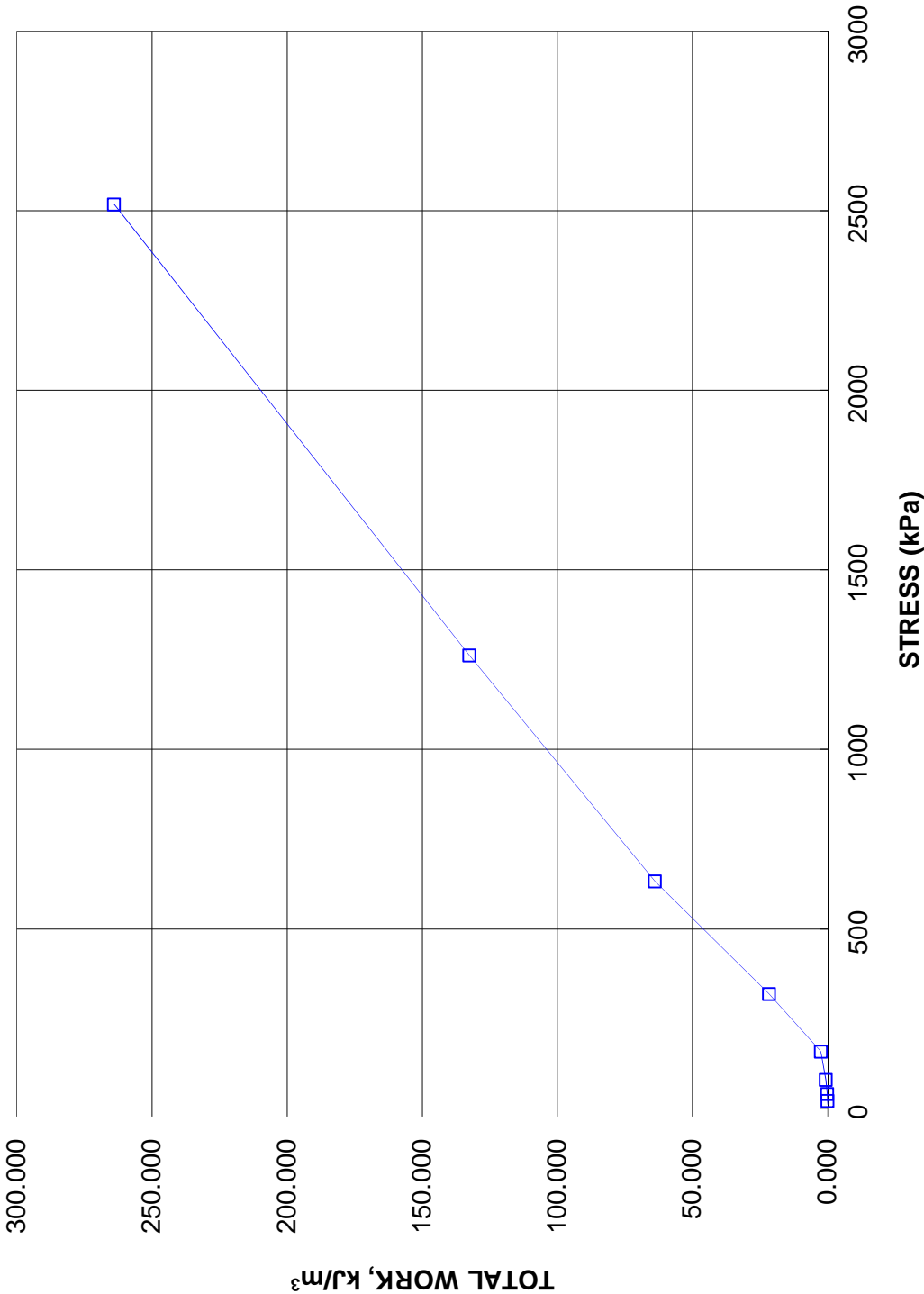
**CONSOLIDATION TEST
VOID RATIO vs STRESS
BH B502-13 SA 10**



CONSOLIDATION TEST
TOTAL WORK VS STRESS

FIGURE B7
Sheet 4 of 4

CONSOLIDATION TEST
TOTAL WORK, kJ/m³ vs STRESS
BH B502-13 SA 10



CONSOLIDATION TEST SUMMARY

FIGURE B8

Sheet 1 of 4

SAMPLE IDENTIFICATION

Project Number	09-1111-6014	Sample Number	10
Borehole Number	S502-20	Sample Depth, m	9.14-9.74

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	12/11/2013		
Date Completed	01/02/2014		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.56	Unit Weight, kN/m ³	16.91
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	11.24
Area, cm ²	31.54	Specific Gravity, measured	2.75
Volume, cm ³	80.58	Solids Height, cm	1.065
Water Content, %	50.49	Volume of Solids, cm ³	33.57
Wet Mass, g	138.95	Volume of Voids, cm ³	47.01
Dry Mass, g	92.33	Degree of Saturation, %	99.2

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	2.555	1.400	2.555				
6.26	2.553	1.399	2.554	1	1.38E+00	1.00E-04	1.36E-05
10.91	2.551	1.396	2.552	34	4.06E-02	2.27E-04	9.04E-07
20.98	2.547	1.392	2.549	94	1.46E-02	1.63E-04	2.34E-07
40.45	2.535	1.382	2.541	167	8.20E-03	2.23E-04	1.79E-07
79.24	2.511	1.359	2.523	184	7.33E-03	2.49E-04	1.79E-07
98.58	2.499	1.348	2.505	1815	7.33E-04	2.37E-04	1.70E-08
40.45	2.507	1.355	2.503				
10.91	2.519	1.366	2.513				
40.45	2.510	1.358	2.515	42	3.19E-02	1.15E-04	3.61E-07
79.24	2.501	1.349	2.506	43	3.10E-02	9.79E-05	2.97E-07
98.58	2.495	1.344	2.498	2953	4.48E-04	1.15E-04	5.06E-09
156.82	2.462	1.313	2.478	1717	7.58E-04	2.24E-04	1.66E-08
311.93	2.232	1.097	2.347	1270	9.19E-04	5.80E-04	5.22E-08
622.63	2.000	0.878	2.116	508	1.87E-03	2.93E-04	5.36E-08
1246.39	1.855	0.742	1.927	227	3.47E-03	9.09E-05	3.09E-08
2491.36	1.728	0.623	1.791	194	3.51E-03	4.00E-05	1.37E-08
1246.39	1.733	0.628	1.730				
311.93	1.768	0.661	1.750				
98.58	1.796	0.687	1.782				
20.98	1.841	0.730	1.819				
6.26	1.878	0.764	1.859				

Note:

Specimen taken 19-29 cm from bottom of the tube
k calculated using cv based on $\dot{\epsilon}_0$ values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

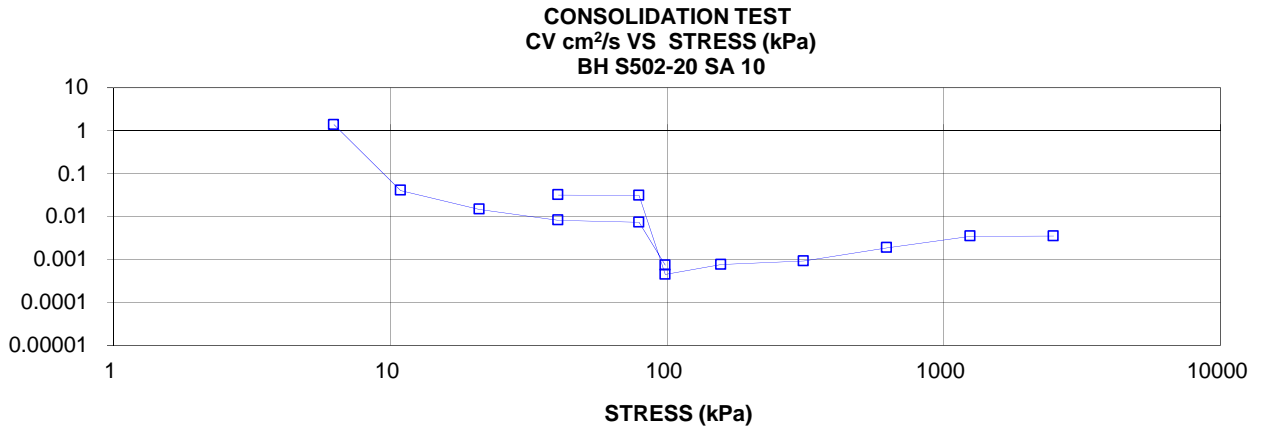
Sample Height, cm	1.88	Unit Weight, kN/m ³	19.83
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	15.29
Area, cm ²	31.54	Specific Gravity, measured	2.75
Volume, cm ³	59.22	Solids Height, cm	1.065
Water Content, %	29.69	Volume of Solids, cm ³	33.57
Wet Mass, g	119.74	Volume of Voids, cm ³	25.64
Dry Mass, g	92.33		

CONSOLIDATION TEST SUMMARY

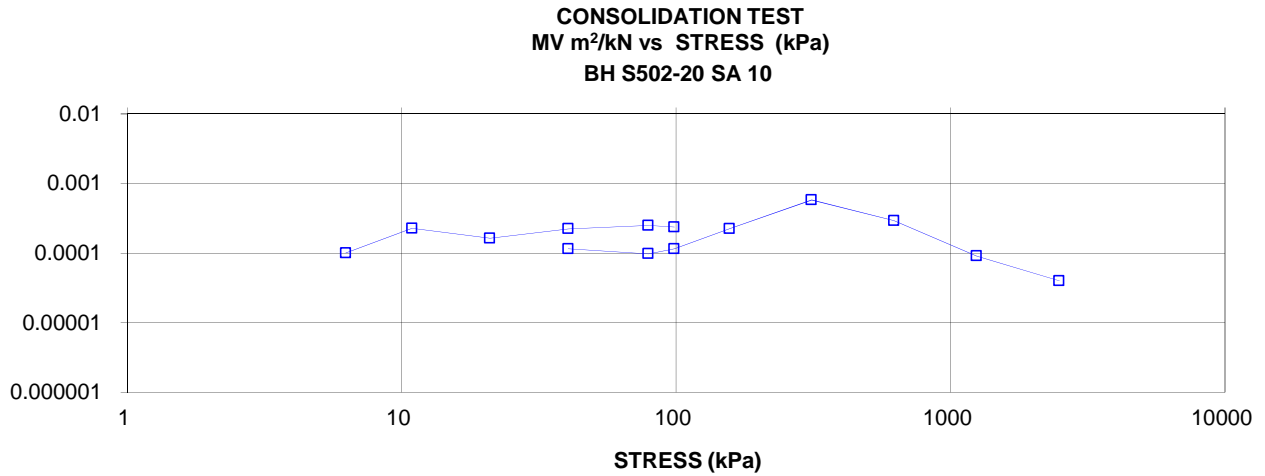
FIGURE B8

Sheet 2 of 4

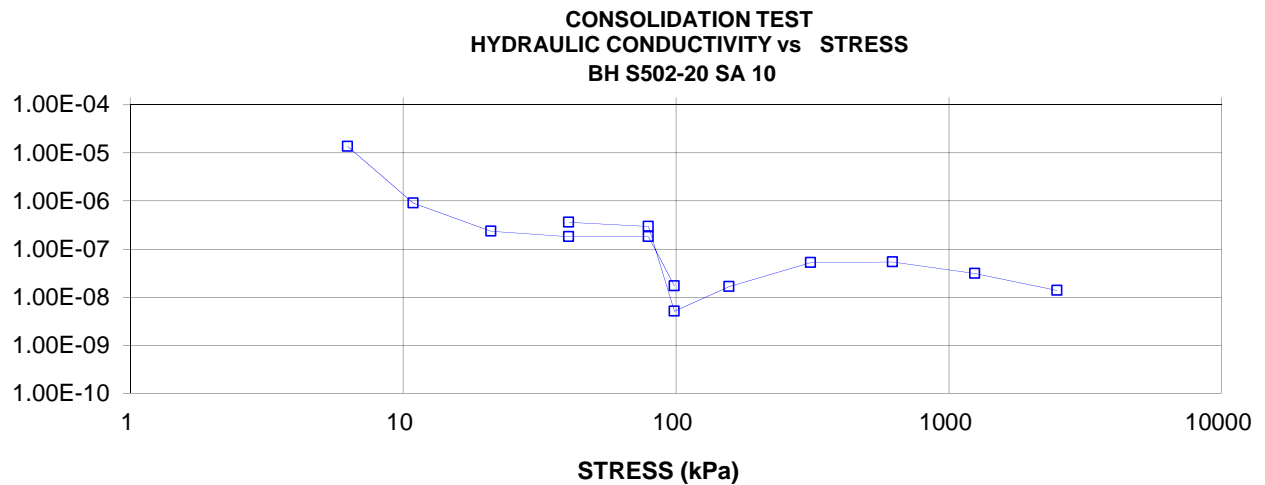
COEFFICIENT OF CONSOLIDATION,
cm²/s



VOLUME COMPRESSIBILITY, m²/kN



HYDRAULIC CONDUCTIVITY,
cm/s



Project No. 09-1111-6014

Prepared By: LG

Golder Associates

Checked By:

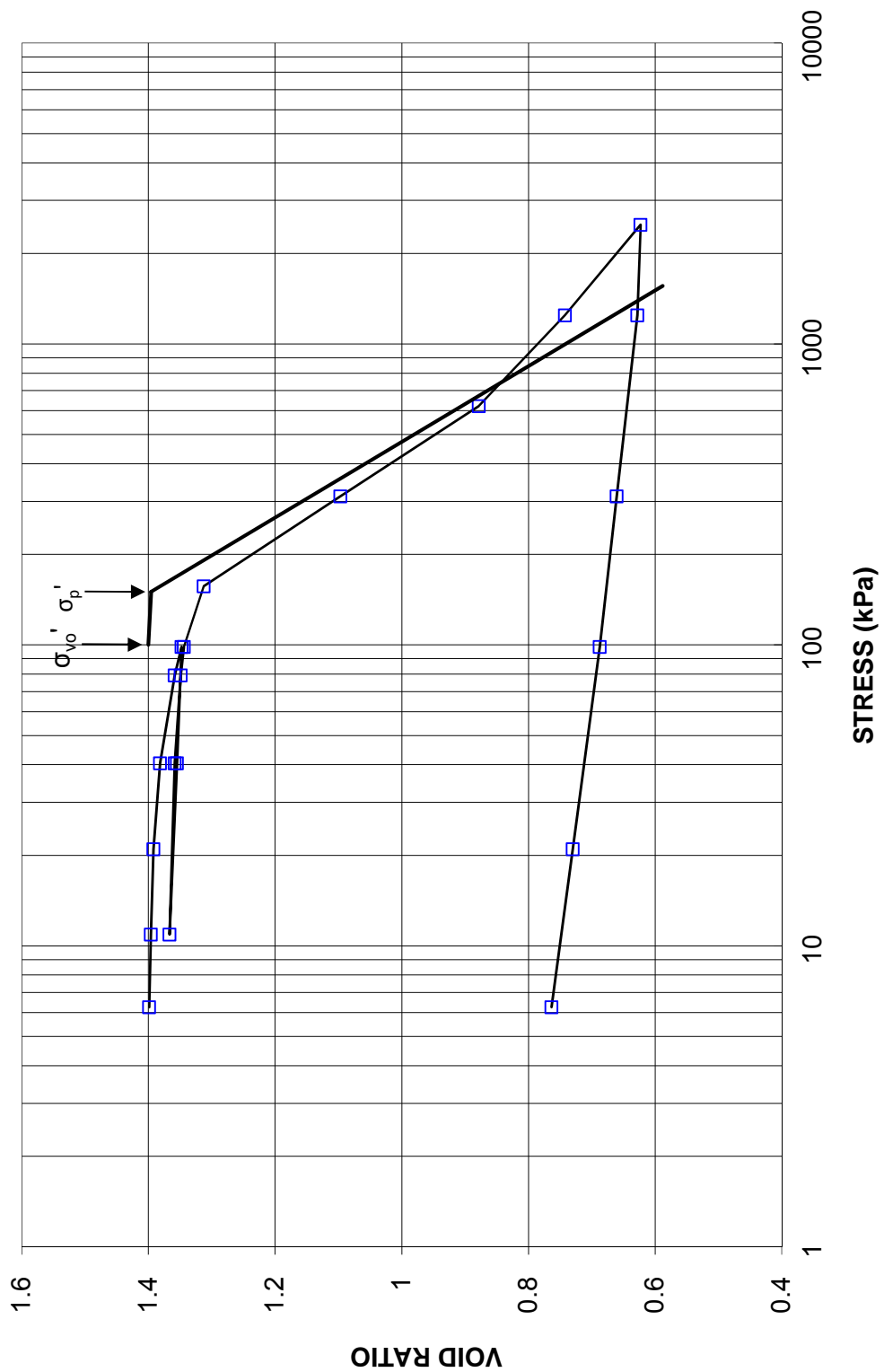
AV

**CONSOLIDATION TEST
VOID RATIO VS LOG STRESS**

FIGURE B8

Sheet 3 of 4

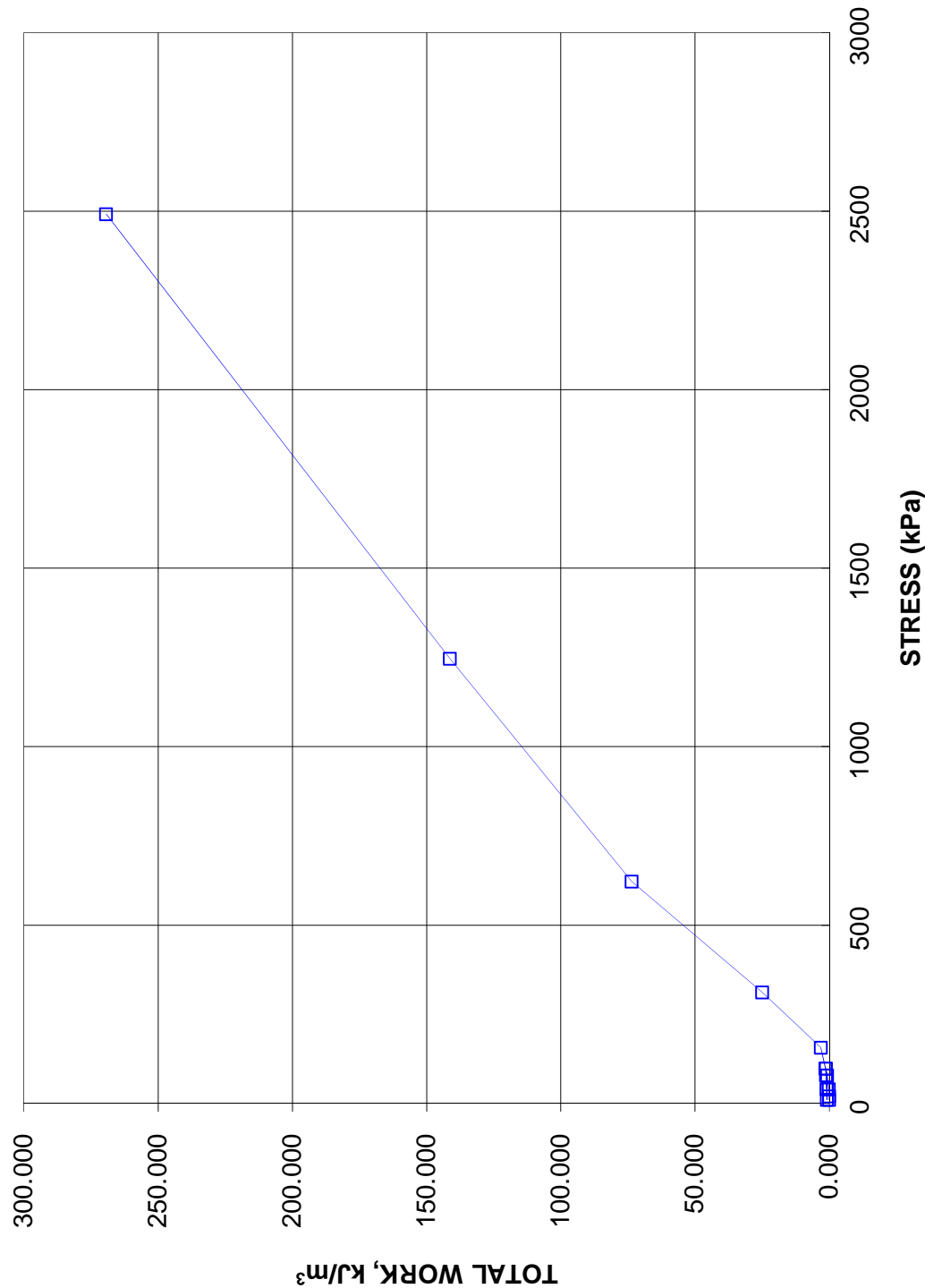
**CONSOLIDATION TEST
VOID RATIO vs STRESS
BH S502-20 SA 10**



CONSOLIDATION TEST
TOTAL WORK VS STRESS

FIGURE B8
Sheet 4 of 4

CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs STRESS
BH S502-20 SA 10



CONSOLIDATION TEST SUMMARY**FIGURE B9**

Sheet 1 of 4

SAMPLE IDENTIFICATION

Project Number	09-1111-6014	Sample Number	1
Borehole Number	S502-20B	Sample Depth, m	5.5-5.9

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	3/18/2013		
Date Completed	3/31/2014		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	16.95
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	11.13
Area, cm ²	31.43	Specific Gravity, measured	2.76
Volume, cm ³	79.77	Solids Height, cm	1.043
Water Content, %	52.30	Volume of Solids, cm ³	32.80
Wet Mass, g	137.86	Volume of Voids, cm ³	46.97
Dry Mass, g	90.52	Degree of Saturation, %	100.8

TEST COMPUTATIONS

Stress	Corr. Height	Void Ratio	Average Height	t ₉₀	cv.	mv	k
kPa	cm		cm	sec	cm ² /s	m ² /kN	cm/s
0.00	2.538	1.432	2.538				
5.85	2.541	1.435	2.540				
10.81	2.538	1.432	2.540	1220	1.12E-03	2.70E-04	2.97E-08
20.59	2.531	1.425	2.534	1192	1.14E-03	2.90E-04	3.25E-08
40.17	2.520	1.415	2.525	1250	1.08E-03	2.23E-04	2.37E-08
79.16	2.497	1.393	2.508	1117	1.19E-03	2.32E-04	2.72E-08
157.05	2.457	1.354	2.477	1024	1.27E-03	2.02E-04	2.52E-08
312.87	2.311	1.215	2.384	2289	5.26E-04	3.68E-04	1.90E-08
624.42	2.070	0.984	2.190	1745	5.83E-04	3.05E-04	1.74E-08
1265.50	1.917	0.837	1.993	923	9.13E-04	9.43E-05	8.43E-09
2513.86	1.786	0.712	1.851	638	1.14E-03	4.12E-05	4.60E-09
1265.50	1.800	0.725	1.793				
312.87	1.833	0.756	1.816				
79.16	1.880	0.801	1.856				
20.59	1.918	0.838	1.899				
5.85	1.959	0.877	1.938				

Note:

Specimen taken 13-18 cm from bottom of the tube

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.96	Unit Weight, kN/m ³	19.14
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	14.42
Area, cm ²	31.43	Specific Gravity, measured	2.76
Volume, cm ³	61.56	Solids Height, cm	1.043
Water Content, %	32.74	Volume of Solids, cm ³	32.80
Wet Mass, g	120.16	Volume of Voids, cm ³	28.77
Dry Mass, g	90.52		

Prepared By: RD

Golder Associates

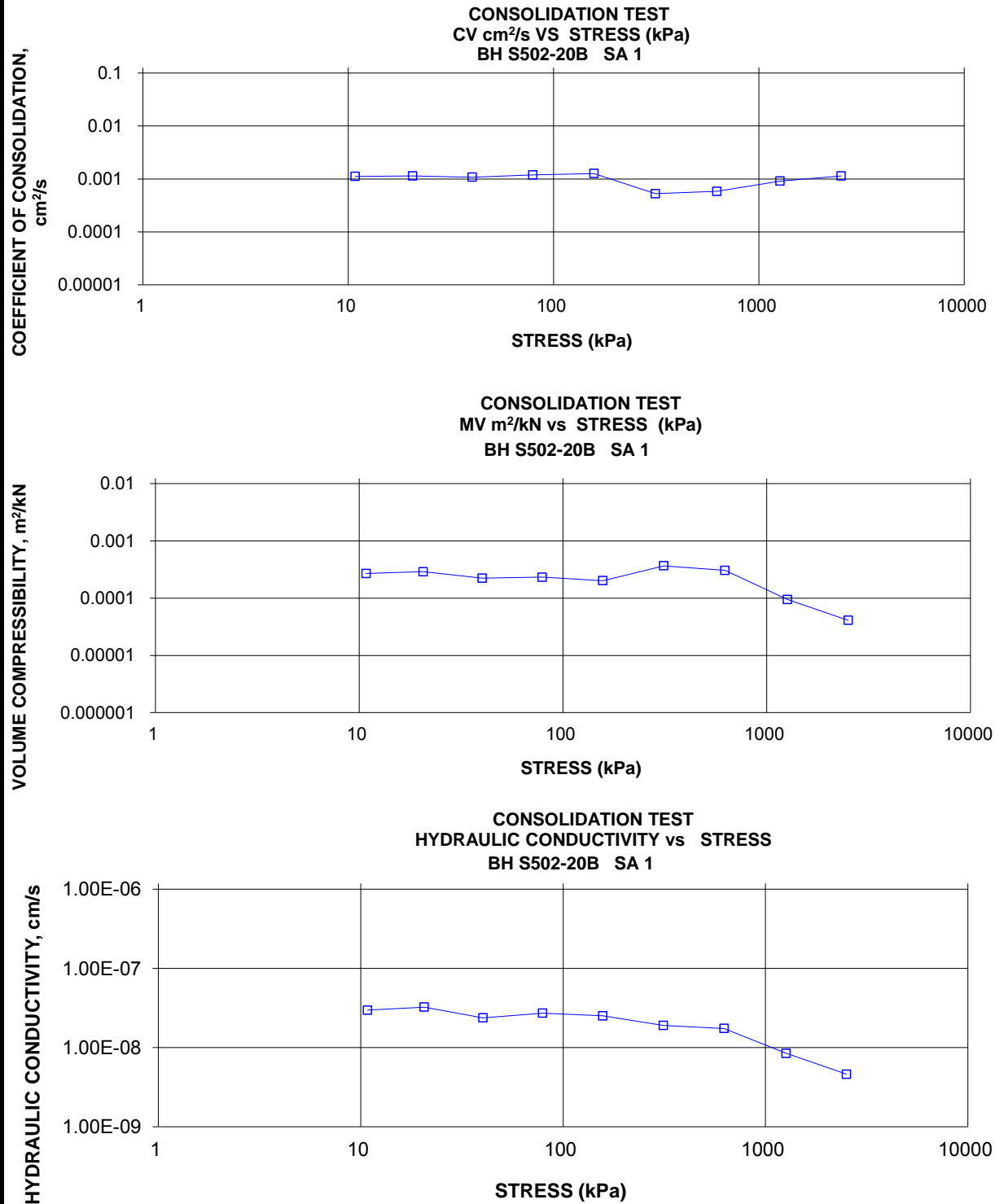
Checked By:

AV

CONSOLIDATION TEST SUMMARY

FIGURE B9

Sheet 2 of 4



Project No. 09-1111-6014

Prepared By: RD

Golder Associates

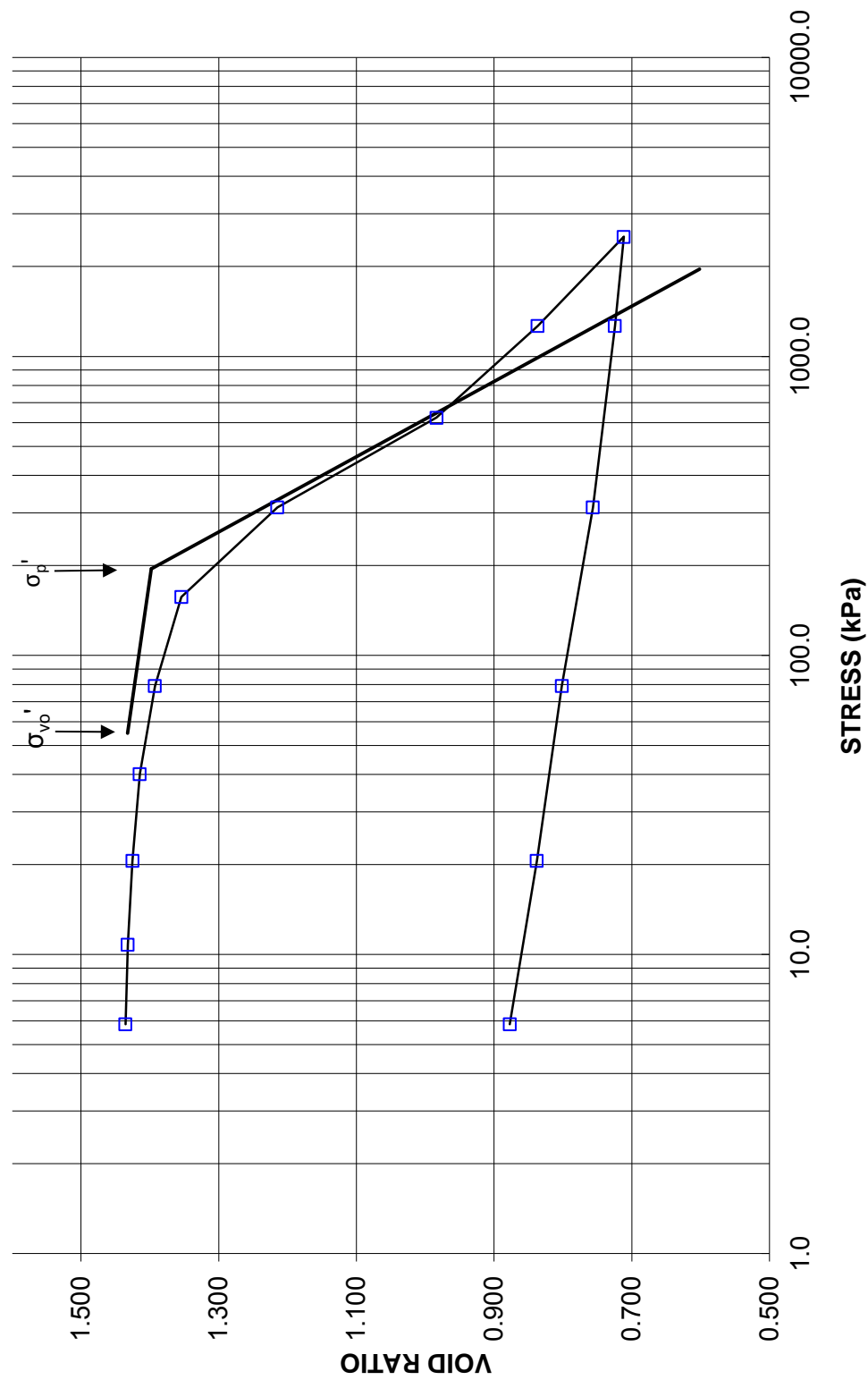
Checked By:

AV

CONSOLIDATION TEST
VOID RATIO VS LOG STRESS

FIGURE B9
Sheet 3 of 4

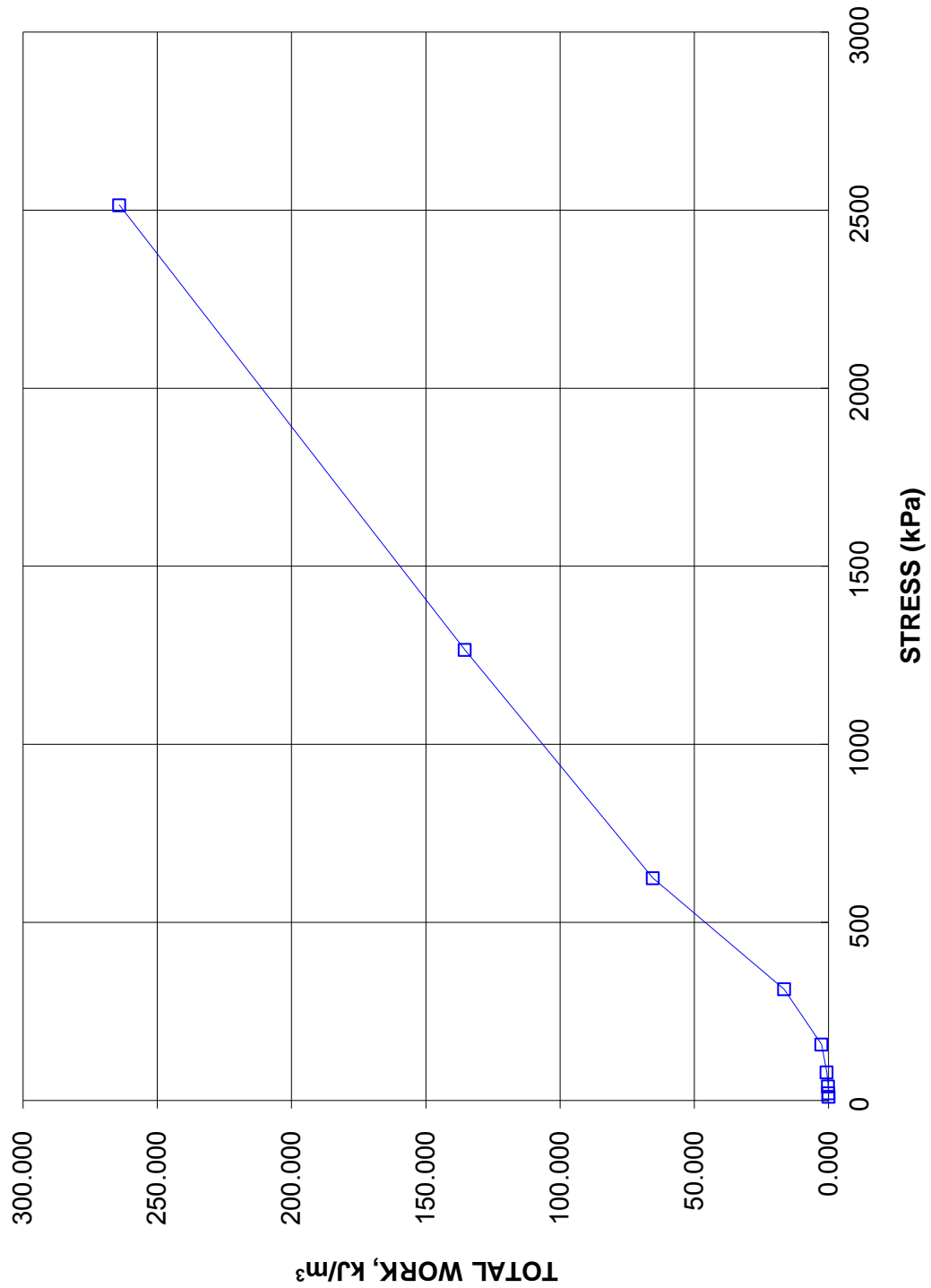
CONSOLIDATION TEST
VOID RATIO vs STRESS
BH S502-20B SA 1



**CONSOLIDATION TEST
TOTAL WORK VS STRESS**

**FIGURE B9
Sheet 4 of 4**


**CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs STRESS
BH S502-20B SA 1**



Three sections of a geological core sample are shown, labeled 1-25, 1-50, and 1-75. The sections are dark, cylindrical, and show various sedimentary layers and textures. Handwritten annotations in red and black ink are visible on the sections. The top section (1-25) has a red 'X' and a red '1-25' label. The middle section (1-50) has a red 'X' and a red '1-50' label. The bottom section (1-75) has a red 'X' and a red '1-75' label. A handwritten note 'END 2ND RUN 51.5'' is visible on the right side of the bottom section.

Photomicrographs of three thin sections of the same sample, showing different mineral textures. The top section shows a dense, fine-grained texture. The middle section shows a more elongated, fibrous texture. The bottom section shows a coarse, crystalline texture. Each section is labeled with its orientation and a scale bar.

0 m	0.25 m	0.5 m	0.75 m	1.0 m	1.25 m	1.5 m
0 ft	1 ft	2 ft	3 ft	4 ft	5 ft	

PROJECT		Straight Lake NBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5145-08-01					
TITLE Bedrock Core Photographs Boreholes B502-01, B502-02 & B502-05							
		PROJECT No. 09-1111-6014				FILE No. ----	
		DESIGN	MT	OCT 15	SCALE	NTS	REV.
		CADD	-- --				
		CHECK	AB	OCT 15	FIGURE B10		
		REVIEW	JMAC	OCT 15			

Borehole B502-06



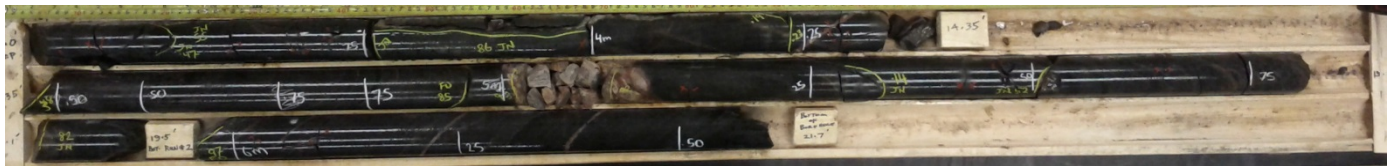
Box 1: 7.9 m – 9.4 m

Borehole B502-07

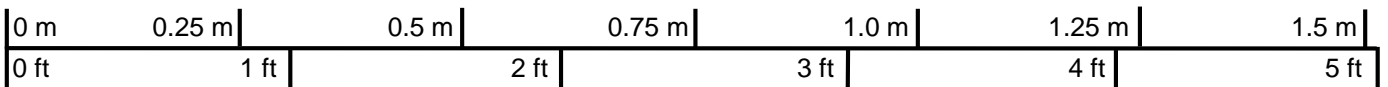


Box 1: 6.3 m – 9.8 m


Borehole B502-09



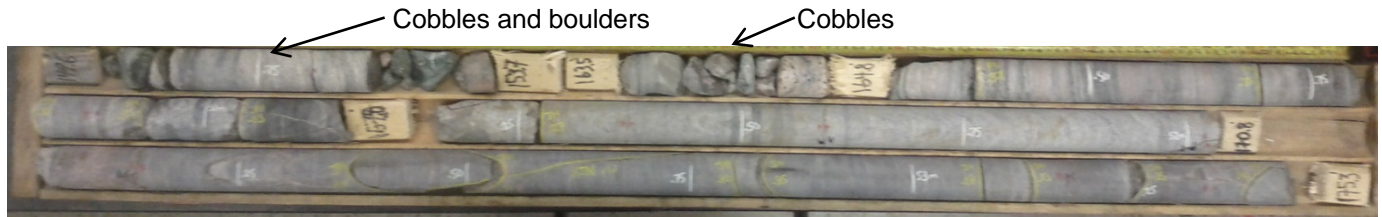
Box 1: 3.4 m – 6.6 m



Scale

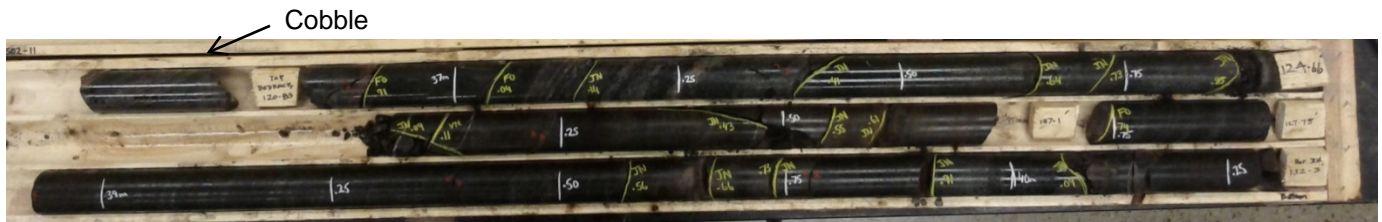
PROJECT		Straight Lake NBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5145-08-01		
TITLE		Bedrock Core Photographs Boreholes B502-06, B502-07 & B502-09		
		PROJECT No. 09-1111-6014		FILE No. ----
		DESIGN	MT	OCT 15
		CADD	--	--
		CHECK	AB	OCT 15
		REVIEW	JMAC	OCT 15
		SCALE NTS		
		FIGURE B11		

Borehole B502-10



Box 1: 50.2 m – 53.4 m

Borehole B502-11

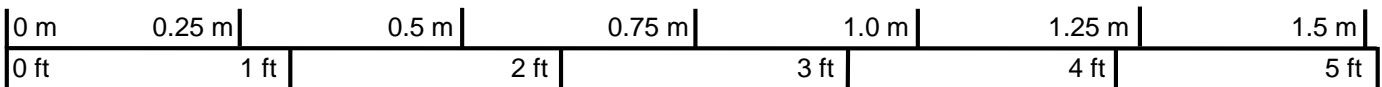


Box 1: 36.8 m – 40.3 m


Borehole B502-12



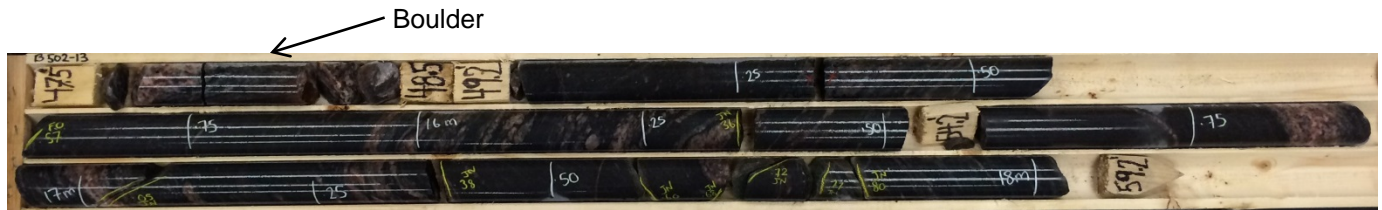
Box 1: 14.7 m – 18.0 m



Scale

PROJECT		Straight Lake NBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5145-08-01			
TITLE		Bedrock Core Photographs Boreholes B502-10, B502-11 & B502-12			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	MT	OCT 15	SCALE NTS
		CADD	--		REV.
		CHECK	AB	OCT 15	FIGURE B12
		REVIEW	JMAC	OCT 15	

Borehole B502-13



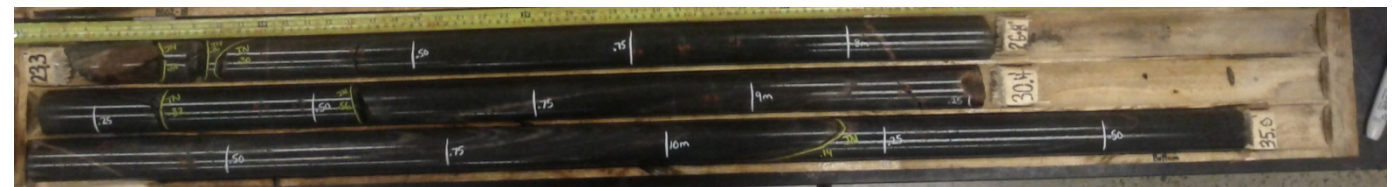
Box 1: 15.0 m – 18.0 m

Borehole B502-15

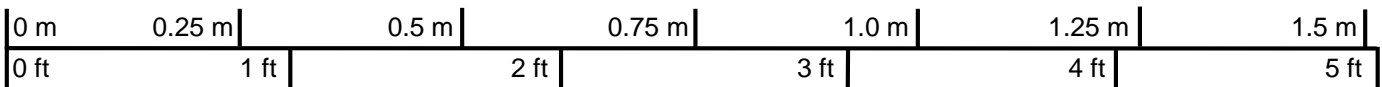


Box 1: 2.4 m – 5.6 m


Borehole B502-18



Box 1: 7.1 m – 10.7 m



Scale

PROJECT		Straight Lake NBL Bridge Structure Highway 69 GWP 5005-10-00; WP 5145-08-01			
TITLE		Bedrock Core Photographs Boreholes B502-13, B502-15 & B502-18			
		PROJECT No. 09-1111-6014		FILE No. ----	
		DESIGN	MT	OCT 15	SCALE NTS
		CADD	--		REV.
		CHECK	AB	OCT 15	FIGURE B13
		REVIEW	JMAC	OCT 15	

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
6925 Century Avenue, Suite #100
Mississauga, Ontario, L5N 7K2
Canada
T: +1 (905) 567 4444

